

Vol. XX, No. 2

MARCH 1953

# THE SCIENCE TEACHER

*1953 Annual National Convention*

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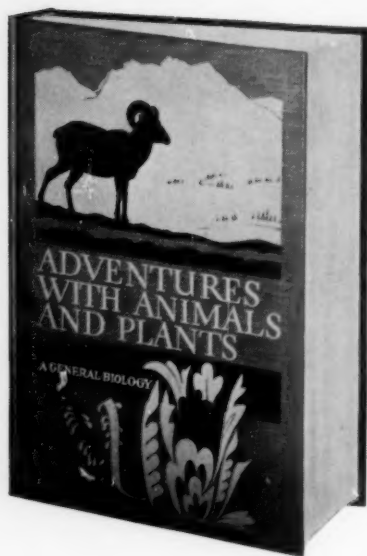


- Implementation of Basic Principles of Good Science Teaching
- Textbook Needs in Elementary Schools, High Schools, and Colleges
- A Primary-Grade Unit on Machines
- Highlights of the Pittsburgh Convention
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## Guided Missives

May I take this opportunity of expressing my admiration of the Association's activities, in particular the improvement in "The Science Teacher" and also the packet service. This latter is intensely interesting and useful, even in another country and at this distance.

E. F. DODSON  
Auckland, New Zealand

We have received your letter in response to our request for panel names of educators qualified to select text materials for United States Armed Forces Institute courses.

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HOWARD V. EVANS  
Acting Chief, Curriculum Division USAFI  
Madison, Wisconsin

I have received six copies of your publications which you sent to us at the request of Prof. Daniel Snader of the University of Illinois. My staff joins me in sending you our great appreciation for your considerate action.

May we take this opportunity to ask you for your future cooperation with our company in our effort to produce better textbooks for the Japanese schools at this very important time of transition? Please let us know if there is anything we can contribute to your association.

With many thanks and wishes for the prosperous future of your association.

YOSHITARO KAWGUCHI, President  
Gakko Tosho Company, Ltd.  
Tokyo, Japan

I seriously question whether THE SCIENCE TEACHER deserves the praise given it in recent "Guided Missives." I get lots more science from other magazines and its articles on teaching are not much help to a classroom teacher. However, I am renewing my membership because I suppose much of the Association's work is not evident to a member.

A CLASSROOM TEACHER

EDITOR'S NOTE: Extracted from a letter written in good faith; name withheld on request.

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## THE SCIENCE TEACHER

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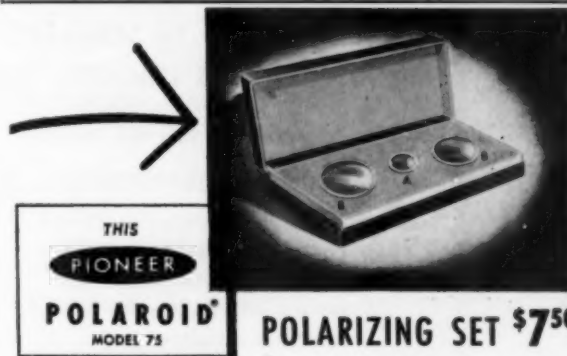
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The National Science Teachers Association is a department of the National Education Association and an affiliate of the American Association for the Advancement of Science. Established in 1895 as the NEA Department of Science Instruction and later expanded as the American Council of Science Teachers, it merged with the American Science Teachers Association and reorganized in 1944 to form the present Association.

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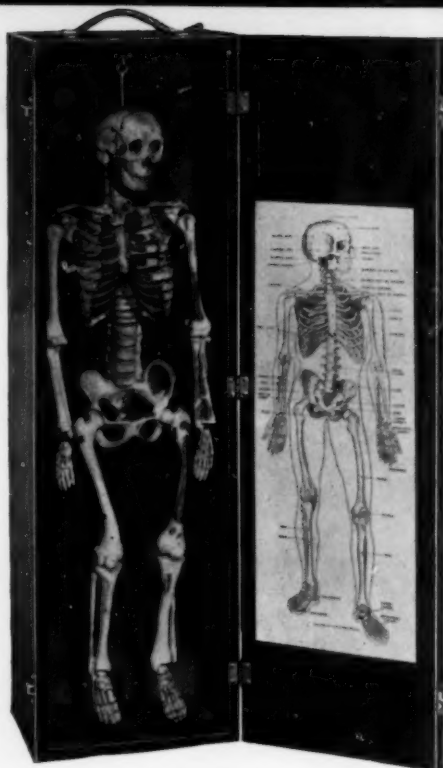
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# BASIC PRINCIPLES OF *Science Teaching*

FRANCIS D. CURTIS

Keynote address  
of the joint programs of the NSTA,  
NABT, ANSS, and Section Q (AAAS),  
on "Implementation of Basic Principles of Good  
Science Teaching," presented at the Fifth Annual Joint  
Conference of the Science Teaching Societies  
Affiliated with the American Association for the  
Advancement of Science, at St. Louis,  
December 27, 1952.

In education, as in other fields, often a technical term has more than one meaning. Such is the case with the term "principle." In the Cardinal Principles of Education,<sup>1</sup> long considered an educational pronouncement of major significance, "principle" is used to designate an ultimate objective of all education. In The Thirty-first and Forty-sixth Yearbooks,<sup>2</sup> "principle" is defined as "a generalized statement that summarizes many scientific facts." In certain textbooks, whose titles or prefaces indicate that these books are intended to present the "principles" of certain science courses, the word is used to mean "the essential elements" of those courses. In this paper and in those that will follow it on this program, the term "principle" is used with still another meaning. In these discussions a principle is a guide to effective teaching.

There is, of course, no unanimous agreement with respect to what are the basic principles of teaching in any field. The fact that such principles are rarely separate and distinct, but that each may overlap or supplement one or more others, renders the assembling of a standard list impossible. It is

hoped, however, that the ones hereinafter discussed will be found generally acceptable. They are here stated positively as if their validity were beyond question. But it is recognized that the statements of such principles can only be expressions of opinion.

It seems logical to head this list of teaching principles with those that relate to objectives:

1. *The fundamental basis for determining the objectives of every science course (as indeed of every course in every field) is a consideration of the nature of the TRAINING that that course is intended to provide.* From this point of view, the study of any course, any sequence of courses, or any unit is never an end in itself; it is only a means of securing the *training* that such offerings have been designed to provide.

The second principle follows as a logical corollary of the first:

2. *The stated objectives of any science course are appropriate only if the means by which they can be implemented have already been devised, or can, with reasonable certainty, be invented.* Some, at least, of the commonly stated objectives of science courses are too general to be truly meaningful. They express wishful thinking and often also a fantastic reliance upon the completeness of transfer of training. To illustrate, for a decade or more after the Cardinal Principles had been published, teachers of high-school subjects commonly included one or more of the Cardinal Principles in the lists of objectives of their courses. Probably everybody, then and now would accept every one of the seven principles as "a consummation devoutly to be wished." Yet, more than thirty years after the Cardinal Principles were hailed as the dawn of a new age in education, we do not yet definitely and specifically know the practical means and procedures by which to achieve them. We do not yet know how to ensure that our courses will contribute to the development of ethical character,

<sup>1</sup> *Cardinal Principles of Education*. United States Bureau of Education, Bulletin 1918, No. 35.

<sup>2</sup> *The Thirty-first Yearbook of the National Society for the Study of Education*, Part I. Bloomington, Illinois: Public School Publishing Co., 1932.

*The Forty-sixth Yearbook of the National Society for the Study of Education*, Part I. Chicago, Illinois: The Chicago University Press, 1947.

citizenship, worthy home membership and others of the seven notable objectives.

The third and fourth principles, also corollaries of the first, may properly indicate defensible major objectives of science teaching:

3. *Science education at every level should be organized and presented so as to develop skills in reflective thinking and problem solving.* Reflective thinking and problem solving are by no means identical; but they are inseparable. Moreover, training in both is fundamentally training in the use of scientific method. Throughout every day we are encountering and defining problems that we must solve. We are gathering, sorting out in our minds, and evaluating pertinent facts that we can use in solving these problems. We are hazarding guesses (hypotheses) as to probable answers to them. We are making inferences and arriving at conclusions. All these and other universal activities are applications of the various elements of scientific method, so ably identified by Keeslar.<sup>1</sup>

Commonly a mention of skills in science training calls to mind the manipulative skills of the sort determined by Horton<sup>2</sup> for effective experimenting in chemistry. But the acquiring of such skills, essential as they are, is probably never a major objective of any course. Like skill in applying the scientific method, they are merely means to the major end of problem solving.

4. *Science education at every level should be organized and presented so as to stimulate, guide, and develop scientific interests, attitudes, and appreciations.* Much is already known about ways of developing scientific interests. Probably every teaching method, device, or resource employed in teaching is potentially a means of stimulating, guiding, and developing such interests. But persisting interests are not inevitably concomitant outcomes of any science course. They germinate and grow only through alert and skillful teaching.

The development of scientific attitudes, appreciations, and in certain respects, ideals, may be termed emotional objectives. The implementation of these objectives is still in its rudimentary stages. We must reluctantly admit that as yet we have made little definite progress in developing the scientific attitudes beyond the initial intellectual stage in which boys and girls learn what reactions and behaviors are commonly acceptable, socially and ethi-

cally, in situations involving these attitudes. They know what their attitudes and ideals should be, but their conduct often reflects a total disregard of these attitudes and ideals. The truth of this statement is markedly evident as it applies to such of the scientific attitudes as are fundamental to the elimination of superstition, intolerance, bigotry, gullibility, snobbery, ready and uncritical acceptance of propaganda, and other socially undesirable manifestations.

How, with certainty, to develop appreciations, also, is not yet known. We can only hope that we are succeeding in kindling them at least to some extent through presentations and discussions of the contributions of great scientists, and of the growing importance of science in modern life.

5. *The achieving of every objective of science must begin with the building of understandings.* There are three levels of understandings: The lowest level is achieved by the learning of facts. The second is gained through the building of factual information into understandings of scientific principles, or generalizations. These principles are of the sort stressed in the Thirty-first and Forty-sixth Yearbooks, and identified through the commanding researches of Wise<sup>1</sup> and Martin.<sup>2</sup> Examples of such principles are these: "Every living thing is always engaged in the constant struggle to remain alive," and "The amount of useful work that can be got out of any machine is always less than the total amount of work put into it."

The third level of understandings is established by the synthesis of facts and principles into broad understandings. Such understandings are commonly designated by such titles as "Sanitation," "The conservation of renewable and non-renewable resources," "The living world," "The parade of living things," "The possibilities and limitations of machines," and "The atomic age."

It is obvious that merely teaching facts or merely effecting a comprehension of principles and broad areas is not an appropriate objective of any science course. For knowledge itself is of dubious value unless its possessor can recognize the circumstances under which to use it and has learned how to use it. Knowledge is only a means to important ends. To be of real value, it must be made functional; the great chasm between possessing knowledge and being able to use it must be bridged.

<sup>1</sup>Orean Keeslar, "The Elements of Scientific Method." *Science Education*, XXIX (December, 1929), 213-78.

<sup>2</sup>Ralph E. Horton, *Measurable Outcomes of Individual Laboratory Work in High School Chemistry*. Contributions to Education, No. 303. New York: Teachers College, Columbia University, 1928.

<sup>1</sup>Harold E. Wise, "A Determination of the Relative Importance of Principles of Physical Science for General Education." *Science Education*, XXV (Dec. 1941), 371-79 and XXVI (Jan. 1942), 8-12.

<sup>2</sup>W. Edgar Martin, "A Determination of the Principles of the Biological Sciences of Importance in General Education." *Science Education*, XXIX (March and April-May, 1945), pp. 100-105 and 152-63.

Therefore, we must make certain to train those in our classes to apply facts, principles, and broad understandings in their daily living.

A brief assaying of the functional potentialities of understandings at the three levels seems now in order; facts are the fundamental and indispensable materials of all science training. This statement holds true whether the learner gains the facts through his own experimenting and observing, or learns them vicariously through reading. Yet, of the millions of available scientific facts, only a relatively small percentage are in themselves worth knowing for their potentially functional values. All of us can, of course, readily think of exceptions to this statement. For example, knowing the exact characteristics of Black Widow spiders is without question potentially worthwhile knowledge if one shares a habitat with Black Widow spiders. Again, knowing that salt will melt ice *can* increase one's chances for surviving in a sleety climate.

But, granted that certain facts do possess potentially functional values, these values usually depend on the precise accuracy with which they can be recalled. And it is distressingly true that the keen edge of factual knowledge quickly becomes dulled, if the facts are not frequently reviewed. Probably the most striking evidence of the ephemeral nature of purely factual information taught in science courses is provided by the findings of epoch-making studies by Tyler and others.<sup>1</sup> The pooled results of these researches revealed that within a year after high-school pupils and college students had completed courses in science, they had forgotten as much as 77 per cent of the facts that they knew upon completing those courses. The inescapable conclusion from such findings would seem to be that a course that emphasizes the mere learning of scientific facts as an end in itself, is likely to prove subsequently to have been almost a complete waste of teachers' and pupils' time and energy.

In contrast, however, with the rapid and extensive forgetting of facts is the high degree of retention of the ability to apply mastered scientific prin-

ciples. The series of studies just cited produced substantial evidence supporting this statement. In the same period during which the subjects had forgotten most of the facts that they had learned in the various courses, they had suffered little or no loss of ability to apply principles. In fact, three years after the end of one course, the students had forgotten on the average about 72 per cent of the factual information, but they had *gained* 58 per cent in their ability to apply principles. Perhaps the reason why the ability to apply scientific principles is retained is that, if a person thoroughly understands a scientific principle, he is continually identifying situations in which he can apply it. Thus is supplied the drill necessary for retention. Obviously the extent to which a broad understanding, such as conservation or the uses and limitations of machines, can become dynamic must depend directly on the completeness with which the understandings of its foundational principles have become functional.

All the data and inferences just presented seem logically to support another principle of science education:

6. *The facts that are introduced into a science course or are planned for discovery in it, should be primarily selected so as to facilitate the development of understandings of scientific principles or generalizations.*

Let us briefly digress from a consideration of the importance of scientific principles in the science curriculum to consider their importance in other curricula. A fact not commonly realized is that an understanding of scientific principles is fundamental to a thorough comprehension and appreciation of problems and materials in fields not generally regarded as being closely related to science. Prominent among such fields are the social studies and English. How could one fully comprehend and interpret such phenomena as the emigrations of individuals and peoples, exploitation and other manifestations of social parasitism, the rise of organized labor and other developments in industry, and wars and economic conquests, unless one had acquired clear understandings of the principles of biological and physical science that underlie these social phenomena? How could one fully savor the richness of great literature without a broad foundational background of scientific principles with which to interpret plot and character development?

These considerations alone would seem to justify in the high-school program of studies, a required sequence of science courses designed to achieve a functional understanding of the scientific principles most generally useful.

<sup>1</sup> Ralph W. Tyler, "What High-school Pupils Forget." *Educational Research Bulletin*, Ohio State University, IX (November 19, 1930), 490-92.

Ralph W. Tyler, "Permanence of Learning." *Journal of Higher Education*, IV (April, 1933), 203-04.

Palmer O. Johnson, "The Permanence of Learning in Elementary Botany." *The Journal of Educational Psychology*, XXI (January, 1930), 37-47.

J. A. Cederstrom, "Retention of Information Gained in Courses in College Zoology." *The Pedagogical Seminary and Journal of Genetic Psychology*, XXXVIII (December, 1930), 516-17.

F. P. Frutchey, "Retention in High School Chemistry." *Educational Research Bulletin*, Ohio State University (February 17, 1937), 34-37.

James E. Wert, "Twin Examination Assumptions." *Journal of Higher Education*, VIII (March, 1937), 136-140.

7. *The essential materials to be taught in any course should be rigorously limited to an amount that can be taught thoroughly.* Course materials have tended to increase in scope and volume as knowledge has accumulated. As a result, every successful textbook or syllabus, in order to provide the materials that a majority of the teachers of the course demand, must contain more material than can probably be thoroughly taught to any class within the available time and with the available facilities. Yet, in many situations the teacher is required, or at least, expected to "cover the whole course" in more or less complete disregard of the variations in class sizes, and in the capabilities and potentialities of the pupils. Such a prescription is indefensible. Selection of course content is mandatory. In any course, only those materials are justifiably included for mastery that are needed for achieving the desired types and degrees of training appropriate to the needs and capacities of the pupils in that course. Thus, a bright class would cover several times as much material as a dull class, though understandings of the most important scientific principles fundamental to that course, would be developed in both classes. Therefore, voluminousness of available teaching materials is an asset. It provides a means of meeting differences in classes, as well as in pupils.

8. *Meaningful learning starts with a problem in the learner's mind and involves exploration and discovery by the learner.* This principle is an adaptation of Dewey's celebrated thesis, "We learn to do by doing." Doing in this case connotes actively securing knowledge, not passively absorbing it. Within the past two decades, however, there has been an increasing tendency to teach science vicariously rather than experientially. Especially in the elementary grades, but also, to some extent in junior and even senior high schools and junior colleges, the all-too-common practice is to have pupils read or be told about science rather than have them *experience* science through observing and experimenting. An elementary teacher was recently heard to state proudly, "We have such a fine school library that our boys and girls can find in it the answer to *any* questions about science that they want to ask." When asked, "Do you ever have the boys and girls solve their problems by performing simple experiments and observing demonstrations instead of through reading?" her answer was a militant, "Why, *no!*" Common excuses for omitting such activities from a science course are that there is available no room in which pupils can perform experiments or even a room in which the teacher can demonstrate; that there is

a lack of apparatus and equipment; and that classes are too large to permit the pupils to perform experiments or to observe demonstrations.

Obviously vicarious learning is indispensable in science courses as in all others. But it should be regarded as a *final* resource, and not as the initial, and often the only, resource.

The Forty-sixth Yearbook emphasizes the values to be derived from observing demonstrations. But also it voices the conviction that individual experimenting is essential in every course, and that there is no substitute for it.<sup>1</sup>

Difficult in many situations as the providing for individual experimentation and even for teacher or pupil demonstration unquestionably is, some provision for these essential components of a science course is never wholly impossible. And some experimentation and demonstration, however limited, is better than none at all. Even in the most discouraging teaching situations, where laboratory work as we ordinarily think of it is impossible, the teacher can still provide some individual experimenting through the assignment of simple experiments to be performed out of school. Also, she can provide *some* of the advantages derived from individual experimenting by stimulating and encouraging such activities as work on science hobbies, simple individual projects, and more elaborate ones for science fairs.

9. *In every science course, use should be made of both the inductive method and the deductive method of teaching.* With the inductive method, the problem is first stated and evidence leading to its solution is collected, to the point where an answer can be inferred and stated. The deductive method starts with a general statement and then presents or directs the discovery of the factual evidence needed to sustain or verify it. Thus, induction starts with a question, deduction, with an answer. The classic example of the use of the inductive method is Agassiz' procedures in stimulating a student to learn for himself, through observation and experimentation, all that it was practicable for him to learn about a fish.

Each of these methods possesses unique advantages for certain purposes. The inductive method is far superior for solving problems by experimenting and observing, as in laboratory work and field trips. The deductive method is the only one by which elementary instruction can be given in astronomy, geology, atomic energy and other fields in which pupils cannot gather for themselves the facts necessary for arriving at understandings of many principles that apply to those fields.

When the unquestioned values of the inductive

<sup>1</sup> *Ibid.*, p. 53.

method are reviewed, it is strange indeed that this method is rarely observed in use in elementary and secondary science classes.

10. *In harmony with the democratic conception of education, every individual is entitled to his just share of attention and effort directed toward developing his maximal potentialities.* The statement is not infrequently heard that the instruction in the typical American secondary school is adjusted to the level of the sub-mediocre pupils. This practice is sometimes defended on the grounds that it decreases the proportion of failures. Probably for the same reason, increasing efforts have been manifest during the past two or three decades to devise special courses and to adapt instruction to the dull-normal boys and girls. In fact, in some, perhaps in many, schools a disproportionate amount of the instructional effort seems to be devoted to that segment of the student body who are least capable of profiting from it.

The results of such efforts have not as yet proved generally satisfactory. Some have been definitely unfortunate. Examples of the latter are the construction of certain courses in physical science for the low-ability "generals," or non-college-bound pupils in the upper high-school grades. For some of these courses the subject matter has been emasculated to the extent that the content is scarcely above the level of effortless entertainment. In fact the extremely bad courses of this type are actually of less value in achieving the basic objectives of science instruction than is a good general science course.

Only those of us who have wrestled with the problems of teaching dull-normals can have any clear conception of how arduous and frustrating the assignment to teach them can be. Yet the development of such abilities as they possess is not achieved in classes that merely occupy their time. Abundant psychological evidence reveals that the difference in capacity between dull and bright individuals, while great, are differences in degree but not in kind. Therefore it is heartening to realize that, if given an appropriate amount of work to be covered and sufficient patient and sympathetic teaching, a dull-normal can achieve a serviceable command of some, at least, of the important scientific principles and of the skills of reflective thinking.

But unsuccessful as we have thus far been in teaching dull-normals, we have been even less successful in adapting instruction to the very bright. One reason for this failure in many schools, is that the maximal development of the brightest youngsters is not recognized as a problem of major concern. There exists a complacency due to the con-

viction that bright individuals will "get along all right" without special effort on the teacher's part. A second reason is the difficulty inevitably encountered by a teacher in devising instructional materials and procedures that will optimally develop the potentialities of pupils whose intellectual level is above his or her own. And every teacher is certain to have as pupils, occasional boys and girls who are brighter than he or she is.

Instruction to be maximally effective must be adapted to the capacities and abilities of every individual. Many educators are convinced that individualized instruction can be facilitated through ability groupings by classes. No doubt it can be, though other results of such groupings may be sufficiently undesirable to condemn it. But in the smaller schools, class organization on the basis of I. Q. or on any other basis is administratively impossible. Moreover, in the large schools, where such organization is effected, the homogeneity of the resulting classes is only roughly approximate. There is still the problem of developing every member of every class to the limits of his capacities.

The progress toward devising effective individualized instruction has admittedly been slow. But its rate is accelerating to an encouraging extent. Teachers are learning to use with increasing assurance such teaching aids as assignments of study materials and laboratory work differentiated with respect to extent and difficulty. They are learning to employ with growing effectiveness such invaluable supplementary resources as science projects and science fairs, as well as topics and areas for individual investigation.

11. *Evaluation must be continuous, not only the evaluation of pupil achievement, but also the evaluation of the appropriateness and effectiveness of the teaching methods, procedures, and devices employed.* It is essential to keep in mind that the primary purpose of evaluating pupil achievement is not to secure a basis for marks, but to provide a basis for diagnosing faulty learning to the end that remedial measures may be applied. Stated in another way, the evaluation of pupil achievement serves its chief purpose when it indicates the elements that need further teaching. The application of the expanded Morrisonian formula, teach, test, diagnose, reteach, retest, and again diagnose and reteach is essential to optimal instruction.

In spite of the militant insistence of some parents, unsatisfactory achievement is by no means necessarily the fault of the teacher. It may have resulted from the pupil's inattention, indifference, or sick-

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# Implementing the Basic

The preceding paper by Francis Curtis, in the words of a St. Louis conference attendant, "is one of the most remarkable syntheses of ideas about science education I have heard in a long, long time." We agree; in fact, the full symposium was most provocative and practical. Eleven classroom science teachers from all educational levels gave down-to-earth examples of how they attempt to implement the basic principles of good science teaching. Here-with are three of their papers.

Dr. Curtis, one of the "deans" of science education in America, is Professor of Education at the University of Michigan; is widely known for his school textbooks of science and for his professional writings. Miss Strahler teaches general science and chemistry in the Wilbur Wright High School, Dayton, Ohio; is on leave of absence this year as a Fellow of the Ford Foundation Fund for Education. Mr. Thames teaches physics and radio in the Bemidji, Minnesota, High School; is national chairman of the NSTA Membership Committee. Mr. Klinge teaches biology in Indianapolis, Indiana, Thomas Carr Howe High School; won a first prize in the 1952 Awards for Science Teachers program conducted by NSTA.

## WITH SUPERIOR AND RETARDED STUDENTS IN GENERAL SCIENCE

By VIOLET STRAHLER

IN OUR SCHOOL SYSTEM we have special classes for children whose IQ's range up through about 85. We have prevocational schools for misfitted children with IQ's from 80 to 90. We also have a cooperative, vocational high school for anyone who selects it.

We have no special classes for superior students, no special promotions, no early entrance.

This leaves me with ninth grade science students in general science who range fairly widely in IQ, within each class. I use some ability grouping within classes, and am always searching for and trying to invent new methods for exceptional children in heterogeneous classes. By exceptional children I refer to those whose IQ's are about 120 and above or about 90 and below. These constitute roughly about 20 percent of my classes.

One must not overlook a difference between the educationally retarded and the mentally retarded child. Educational retardation may be due to correctable factors such as health, regularity of school attendance, conditions of the home, quality of instruction in school. Our first duty as teachers of retarded students is to form a social philosophy which should aim to fill the simpler jobs of our society not by people who have tried and failed at jobs of higher learning, but by people who because of proper guidance fit with care and dignity, jobs which match their capacity.

Superior children need less drill, less routine, shorter formal reviews. They do not need as many illustrations. They need chance to develop abstract knowledge. More field trips, more student reports, more activity in science clubs, more work in fact should be required. High standards should be established. They should be given the chance to exercise superior behavior and mental traits and to give more of their ability and talent. They ought to be encouraged to work in groups to counteract egoism. They should develop many special interests. They should be watched for unwholesome work habits. They should be using the library constantly. And the teacher should be superior in mental and physical endowments and should have a broad background.

Retarded children need more drill, but spaced and varied. They should be given less reading time. Excursions and follow-up activity should be prominent. Discussions, talks with other persons, visits to museums, short reports, graphs, photographs, drawings, motion pictures, construction of models, displays, practical experimentation, artistic and dramatic activities are useful with slow learners.

There are some methods that involve a wide range of amounts and kinds of activity. Some allow for many levels of achievement within the same job. These are the methods I favor. They allow for individual differences, provide enrichment. I scanned through my list of pet methods and selected a few of this type to discuss briefly.

1. In our science room is a vertical file of information. It was difficult to keep up to date so I turned a superior student loose with it. He enjoyed the decisions in making subject headings,

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# Principles

## IN HIGH SCHOOL PHYSICS

By MARTIN THAMES

MY CHORE for the next few minutes is to present examples from high school physics to illustrate implementation of some of the points developed earlier by Dr. Curtis. Let me summarize first, however, at least to the extent of phrasing my views as to two imperative needs in teaching, particularly in physics:

1. A teacher in order to be effective and successful must have a definite purpose or reason, capable of being expressed in words, for being in the profession.
2. A teacher, particularly in physics, should try as many new things as possible each year of his teaching.

Returning to the first of these needs, Dr. Curtis has said, "The fundamental basis for determining the objectives of every science course (as indeed every course in every field) is a consideration of the nature of the *training* that that course is intended to provide." A dominant factor here will be what the teacher wants to teach. If you hear of some teacher who is achieving outstanding success, chances are you will find that it is in the course of his "long suit." As an example, in a town in New York that I visited recently, one school was reported to have an outstanding course in horticulture. I checked on the faculty and found that one of the science teachers had unusual information, interests, and skills in this field. Whether the course was of particular value to the school and the community is not the question at this point; it simply shows what happens when a teacher has strong interest in one field and "works" that interest.

If the teacher has an expressible purpose for teaching, he can accomplish his goals through almost any of our science courses. For example, Dr. Curtis said, "Science education at every level should be organized and presented so as to develop skills in reflective thinking and problem solving; and to stimulate, guide, and develop scientific interest, attitudes, and appreciations." This could

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## WITH SUPERIOR STUDENTS IN THE SENIOR HIGH SCHOOL

By PAUL KLINGE

IT IS FITTING and proper for science teachers to give attention to what Dr. Morris Meister has called the deviate learner. Deviates constitute a large enough number of our students. Since they do not learn in the usual manner they challenge the educator and the scientist. The spirit of science is to study the deviations from the norm, not only to describe the variations but to explain the why of these deviations and find how they may be utilized.

Since the deviate learner perceives the field of science from a different viewpoint and in a different manner, the usual methodology for the average learner does not seem applicable. We must face the problem of what to do and how to do it, regardless of how radical the solutions may be in comparison to orthodox teaching and learning. The deviate learner can be compressed into the mold of the majority, and this indeed is the usual program in many schools. But the potentialities of the deviate learner have not been revealed when the orthodox solution has been used.

As my share in this symposium, I shall discuss the possible role of the science teacher on the senior high school level in encouraging the superior science student—the deviate learner whose rate of learning is above average.

We at Thomas Carr Howe High School of Indianapolis, Indiana, a school of about 1300 pupils, initiated an effort five years ago to meet the problem of the superior student in the sciences. Our solution was not radical, but at least it was a beginning, and a beginning that we believe has produced some tangible results.

The science curriculum consists of tenth-grade biology, eleventh-grade chemistry, and twelfth-grade physics. There is no ninth-grade science. Any of the three sciences may be taken to meet the graduation requirements.

After the first twelve weeks of the fall semester, each teacher of sophomore biology is asked to list the students who fall into one or more of four categories. The groups are: (1) students who have definitely decided to major in science; (2) students who have indicated an intention to minor in science; (3) students who are making the top grades

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# Pre-Kindergarten Children Learn About MACHINES

EVELYN STOPAK

This report tells how beginning ideas about machines can be introduced to quite young children. Since the report is based on a specific program geared to a particular group of children, a few words of explanation seem to be in order.

The group consisted of pre-kindergarten children with an age range of three and one-half to four and one-half years. Children of this age cannot read and have a limited fund of experiences on which to draw. They think in the concrete, have a short attention span, and can understand only the simplest of concepts. Planning an elementary science program for them requires that it be really "elementary."

At first I would have felt that a unit on machines would be entirely out of place in a nursery classroom. Books which I referred to offered little help; discussions on the teaching of machines at kindergarten or pre-kindergarten levels are scarce. However, I decided to reserve judgment and observe the children more closely. The books I had read emphasized the importance of presenting a wide variety of sensory experiences on a topic. Thinking these things over, I developed a plan and set out to see what could be done with "machines" with my young charges. I kept in mind two concepts desired to be developed.

1. Machines make our work easier.
2. We use machines all the time.

Because of the informality of a nursery class program, presentation of a "unit" takes a long time. All learning would appear to be incidental. In dealing with children of this age level it is necessary to wait for cues from the children that they are ready for the introduction of the topic and have the necessary background to understand it. Or, one can often structure the situation so that it will provide the necessary experiences on which to build. Introductory activities which I deliberately used included:

1. Placing around the room pictures which showed people working with machines.
2. Picture books about machines placed in conspicuous spots around the room.
3. Placing new "machine" toys around the room for the children to handle and play with.

Our "unit" spread out over some little time. During this time I watched for incidents and opportunities to relate (then and also later on) to the unit. We went on little field trips that provided other such opportunities. Here are some examples of what happened:

1. One day while the group was on the playground, two children came to me saying that they wanted to see-saw. They had a problem, though, because one child was heavier than the other. Sandy, the lighter child, was always up in the air, and Sharon, the heavier child, was always on the ground. I showed them how we could move the board to another notch. They tried it in different notches until they could balance each other. Sandy said, "My side is bigger than hers."
2. One day during free play time the children started trying to pick each other up. I discouraged this, but they continued. There were grunts and groans of exertion. Quietly I moved to one corner of the room and set up a long board with some blocks placed under it near one end. Gradually but soon the whole group gathered around and began asking questions. I asked them if they could think of something they could do with the board. Nobody could. Then I told them I had a new way to lift each other without hurting themselves. Richard "caught on" and stepped on one end of the board; the other end went up. He told Arnold to get on the other end, and Arnold did, and Richard "lifted" him up and down as desired. All the children had a turn and their delight with the new discovery was unbounded. I told them that we were using a lever and that it was a machine which we use to make our work easier.
3. One day we visited a building being built in the neighborhood. We saw many machines being used. The children were fascinated by a man lifting materials to the upper floors by using a pulley. One child commented, "Gee, he must be strong to lift that heavy stuff by himself."
4. It is common practice in the nursery for the teachers to hang the pictures made by the children. One day one of the children wanted to hang his own picture. His painting went up a little lop-sided but it hung. Naturally an epidemic of "I want to hang my picture" broke out. Donny made a hammer out of Tinker Toys and

We hope that this article will serve a two-fold purpose: first, to suggest ideas and ways of working in science for the nearly 10,000 teachers in elementary schools now receiving *THE SCIENCE TEACHER*; second, to suggest an idea to instructors in science education courses in our colleges and universities. Mrs. Stopak, who teaches in the Jewish Community Center Nursery School, Baltimore, Maryland, wrote this report as a term paper in a course she was taking at Johns Hopkins University. The instructor suggested she submit it to *TST*; she did; and we're glad she did so we can present it to you.

said, "Look, Mrs. Stopak; I made a hammer to bang the tacks in with." Everyone made hammers, and pictures went up right and left. Some pictures had ten tacks, some more. The utilitarian purpose of hanging the pictures changed into manipulative fun using hammers and tacks.

The next day the problem arose, "How are we going to hang the pictures we made today if all the tacks are on the ones we made yesterday?" They tried taking some of the tacks out with their fingers but could not do so. When they turned to me for help, I suggested they use scissors (rounded points) to "pry" them out. They used the scissors to remove tacks and hung the new pictures.

5. One day the screw came out of the tongue of our wagon. Since a wagon is one of the most popular toys, the children wanted to fix it right away. We had an impromptu discussion of how to fix it. One child suggested a nail. We got a nail from the janitor and put it through the holes in the tongue and the part of the wagon that holds it. The nail held a few minutes and then slipped out. Another child suggested a bigger nail. We tried this, but it too held for only a little while. Then we looked more carefully at the "other part" of the tongue and found that it had a screw in it before. We got a screw from the janitor's workshop and attached the two parts together. This worked quite satisfactorily. Then I gave a screw to each child and we looked at them carefully. "It goes round and round," said one youngster. I suggested that it looked just like a sliding board that goes round and round.
6. A class project consisted of building a jeep. During the project we talked a lot about machines. "We wouldn't be able to build our jeep without tools." "Machines really help us." "Machines are fun to use." We experimented with different kinds of wheels to see which kind would go best.

Later on when I thought the time was ripe, I introduced discussion questions which I thought

would add up our experiences and result in some ideas which the children would carry away with them. Here are the kinds of questions I suggested:

1. How did we fix the see-saw so that Sandy and Sharon could use it?
2. What new way did we learn to pick each other up without hurting ourselves? What else can we pick up this way?
3. What was the man at the new building doing with the pulley? Was it easier for him to pull the materials up into the building or carry them up a ladder?
4. When we were hanging our pictures, what did Donny make that helped us put the tacks in? How did we take the tacks out? How else do we use scissors?
5. What did we use to fix our wagon when the tongue came out? Which held tighter, the nail or the screw?
6. What machines did we use when we built our jeep? Could we build our jeep without machines? Were some wheels better than others for our jeep?
7. Why do we use machines? Do we use machines very much?

During the study of our "unit," we did many other things. We took some field trips:

1. Visit to a building under construction.
2. Visit to a toy shop to see new toys and some being repaired.
3. Trip to the school basement workshop.
4. Visit to a hardware store.
5. Visit to the school kitchen.

We tried to correlate our activities with learning areas other than science:

1. With music—records ("Building a City," "The Men Who Come to Our House," "The Little Fireman.")
2. With dramatics—acting out parts of different workers in building a new house.
3. Creative language—telling stories about trips, experiences, etc.
4. Games—Who Am I? (carpenter, plumber, mason, etc.); What Am I Doing? (digging, painting, etc.); What Am I Using? (broom, shovel, hammer, etc.)

I found a number of books which were helpful to me in learning more about machines. They included simple story books for elementary school children, ninth-grade science books, a high school physics book, and even a college physics book. I did not attempt to evaluate the results of this "unit," but if the interest of children and the action-reaction situation involving children and teacher are reliable criteria, then I would say that our "machines unit" was a success.

# LAPIDARY AS A SCIENCE ACTIVITY

ROBERT M. BARBER

**D**ON'T throw away that rock! Maybe it can be cut, ground, and polished into a beautiful "cabochon,"<sup>1</sup> suitable for a setting, in a short period of time. Of course, you will need some equipment and knowledge of what to do. You say you don't know anything about this art, nor do you have the equipment? The purpose of this article is to provide enough information about lapidary work to enable any science teacher to start this interesting activity.

## Lapidary Machines

There are various types of lapidary machines on the market, some of which are more complete than others. A complete machine that saws, grinds, sands and polishes can be purchased for approximately \$135. These machines usually consist of a diamond blade for sawing, two grinding wheels (100 grit and 220 grit) for grinding, a standing disc for sanding, and a leather covered buff for polishing. Plumbing attachments are provided but the motor is not included.

By ordering these machines with 6 inch wheels (8-inch or 10-inch wheels are most common) and by omitting the plumbing attachments and rock vice on the saw, these machines can be obtained for under \$100.

There are other types of machines that only grind, sand, and polish which are cheaper in price than those mentioned, but they provide no way of sawing and trimming the rocks.

There are two major types of cuts in gem cutting usually called the "cabochon" and "facet." The "cabochon" is the cut most appropriate for beginners. This cut takes less skill, less equipment and less time than does the "facet" type of cut. Therefore, this article will deal only with the "cabochon" cut.

## Steps from Raw to Finished Stone

There are four main steps to complete from the the raw stone to the finished "cabochon." These steps are as follows: (1) cutting or sawing, (2) grinding, (3) sanding, and (4) polishing or buffing.

<sup>1</sup>(ka'bo'shōn') A stone cut in convex form, polished but not faceted. Webster's Collegiate Dictionary. Fifth edition. Springfield, Mass.: G. & C. Merriam Co., 1942.

## CUTTING OR SAWING

There are two ways of cutting or sawing a stone. One method is the grit or mud saw which is a revolving disk running in a mixture of silicon carbide grit, water, and clay flour.<sup>2</sup> The stone should be fastened with a cement to a holder for this type of cutting. A disk of 20 or 22 gage galvanized iron 10" in diameter, running at a speed of 300 to 400 r.p.m. is standard equipment. Speed can increase up to 500 to 800 r.p.m. with experience.<sup>3</sup> The mud or grit saw is "messy" in operation and slow, but cannot be easily damaged by typical students.

The second type of saw is the diamond saw. This is a steel blade of 6", 8" or 10" in diameter with diamond particles inset and glued to the sides of the blade. A mixture of kerosene and oil is applied to the wheel while cutting to reduce temperature and wash away stone particles. Diamond saws are expensive and students can easily ruin a blade if the stone being cut slips.

No matter what kind or type of saw is used, the first step is to cut the stone with one flat side which will be the base of the "cabochon."

The shape you wish the stone to be should be drawn on the rock so that the trimming can begin. Templates can be obtained that have all shapes and sizes of designs needed. An aluminum welding rod  $\frac{1}{8}$ " in diameter makes a good marking pencil and can be obtained from any welding shop.

The next step is to trim the stone as close to the desired outline as possible. This will cut down the grinding time.

Now the stone is rough cut and is ready for grinding.

## GRINDING

Grinding is done on a carborundum wheel or a silicon carbide wheel usually 8" in diameter and 1" thick. However, 6" and 10" wheels are available. A wheel with a grit of 100 for the first stages of grinding is commonly used. Water is the lubricant that keeps the stone from heating and cracking.

<sup>2</sup>Baxter, William T. "Gem Cutting and Jewelry Making." *Industrial Arts and Vocational Education*, 29:362-5, November, 1940.

<sup>3</sup>Howard, J. H. "Gem-Stone Cutting for the Amateur." *Scientific American*, 146:144-6, March, 1932.

It also washes away grindings. Water can be piped to the wheel from an overhead gravity-feed reservoir, or the bottom of the wheel can be set into water, so that it will always pick up water as it turns.

After this first grinding the stone should be as near to the desired shape as it is possible to make it.

A second grinding wheel with a grit of 220 is used next. This is a finer grit, and the stone should be brought to the exact shape wanted at this stage.

Always examine the stone when dry, because it will look polished when it is wet. All grinding of the stone is done toward the crown of the "cabochon"—away from the edge to avoid chipping. The bottom edge, if beveled very slightly, will also help prevent chipping. Always keep the stone in motion so that no flat surfaces will be formed.

Time spent at this stage will make a better looking stone, since this is the last stage of the grinding. When all saw marks are gone, and the shape is perfect, we can go on to the next step which is sanding.

#### SANDING

Before starting the sanding procedure the stone must be put on a dop stick. A dop stick is no more than a dowel large enough to use as a handle. Attach the dop stick by means of a doping wax or sealing wax. Heat the stone with an alcohol lamp until the wax will melt and smear on the surface. Do not let the stone get too hot, or it will burn or crack. Now, the stone is ready to be sanded.

Sanding is done on a wooden wheel which has a sheet of sanding cloth over the surface. This operation is done dry. The sanding wheel should be turning at 800 r.p.m. The stone should be kept in constant motion and lifted from the wheel frequently so that it will not get too hot and crack.

Between the wooden wheel and the sanding

Here is another article sent to us at the suggestion of one of the writer's science education professors, Dr. Paul Kambly of the University of Oregon. Mr. Barber says he has long been interested in the cutting and polishing of stones; is now incorporating this work as an extra-curricular science activity in his high school located about 70 miles from Crater Lake National Park, an area rich in crystallized minerals. Barber has his B. S. from Oregon State College; is nearing completion of his Master's at the University of Oregon.

cloth some type of soft material such as felt should be used. This gives a pliable surface so that it will conform to the stone.

Examine the stone frequently and when all scratch marks are gone the sanding is complete, and the next step of polishing or buffing is in order.

#### POLISHING OR BUFFING

The final stage of polishing and buffing is done against a revolving felt buffer with a tin-oxide polish as a fine abrasive. The speed of this buffer should never exceed 800 r.p.m. The best polishing speed is 500 r.p.m.

After this process the stone is finished and can be removed from the dop stick. It is now ready for mounting.

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# GENERAL EDUCATION

in the

## *Natural Sciences*

BY CHESTER A. LAWSON

The following is a description of a program for general education in the natural sciences that could serve in either the biological or physical areas or in a combination of both.

The function of a general education course in science should be, at least in part: (1) To make meaningful to the student the nature of science as a type of human behavior that results from man's desire to know more and more about himself and his universe. (2) To give the student some grasp of science as a body of knowledge, and (3) To illustrate the impact or consequences of that knowledge on the life of the individual and upon his culture as a whole.

I am certain that there are a variety of ways in which these objectives might be attained. The particular techniques that are selected should be determined by the caliber of the students concerned. In institutions in which only the best students are enrolled certain methods could be used that would fail completely in institutions where little selection determines the quality of the student population. As my experience has occurred in an institution enrolling students with a wide range of ability the program I will describe best fits this type of situation, though it is at least possible that by careful modification it could be made to fit any situation.

In developing our program we have made certain decisions. One is that the thread of continuity through the course should be one of scientific methods rather than of subject matter. We feel that it is more important that the student understand science in terms of how scientists make discoveries, than in terms of organized facts to be memorized.

We believe that understanding the place of science in a culture with its possibilities and its limitations for solving modern human problems is far more important for the average person than knowing only the abstracted facts of science. This is not to belittle the value of the subject matter of science. Instead it reflects a decision that in such situations where time limitations make it impossible to have both that the one will be emphasized over the other.

A second decision is that as far as subject matter is concerned we will not teach a survey that attempts to cover the whole of scientific subject matter. Instead we will select certain areas for a reasonably concentrated study. The justification for this decision is the simple fact that in one year's time it is impossible to teach the whole of science.

We are forced to select. We are forced to neglect vast areas that are just as important as those we include.

The selection of areas can be made in light of the following criteria. First the area should illustrate the use of a particular method of science. Second, it should be an important area in the history of the development of science, that is, it should exemplify a fruitful idea or ideas. Third, it should be of interest to the student and be teachable and, fourth, it should have had a fairly obvious impact or relationship to the life of the average person.

The third decision is that in so far as possible the course should require active student participation. One of our major reasons for concentrating on the methods of science is the fond hope that the students will not only have a better understanding and appreciation of scientific activity as performed by scientists, but that they also will carry some small part of this activity into their daily lives. We suspect that there is little transfer from classroom to living room, and we also suspect that critical thinking is the product of the total situation rather than the application of specific rules at anytime and anyplace. Nevertheless, the student will never think critically in any situation unless he first learns to think critically in one situation.

Perhaps the ideal method for obtaining student participation in the solution of a problem is to have the student choose a problem arising from his personal experience and then give him the physical facilities for working on the problem and last but not least—leave him alone, as Agassiz is said to have done with David Starr Jordan. If you have

Michigan State College has been trying an interesting educational experiment for nearly ten years; namely, a program of general education courses organized in a Basic College apart from other units of the college. Until two years ago, two of the seven basics were "Physical Science" and "Biological Science." These have now been combined within a Department of Natural Science, headed by Dr. Chester A. Lawson.

Dr. Lawson in this paper tells of the guiding philosophy underlying the department; he outlines the main areas of content within the course, and delves somewhat into methods. His discussion should be helpful to others working at the college level and also to the increasing numbers of science teachers in high schools concerned with "general education in science."

This paper, Contribution No. 58 from the Department of Natural Science, Michigan State College, was presented at an NSTA session of the St. Louis meeting, December 29.

two or three or even ten or twenty students this could be done. But when the numbers are two, three and four thousand it is impossible. Because we have enrollments in the thousands we cannot use the ideal method. For a substitute we are developing a laboratory guide that imposes a problem and then leads the student by means of data and the student's own reasoning ability to the final understanding that we hope to achieve. These laboratory studies are far from perfect at this time, but we are learning and revising and rebuilding year by year.

One thing we have learned is that for some students the laboratory guide leads only to confusion because we start too simply, with things that the student already knows. To correct this we are collecting pretest information about student's knowledge and by building on this we hope to eliminate this difficulty.

Another criticism is that by leading the student through a predesigned pattern we are structuring the thinking process too narrowly and not really giving the student a chance to break out on his own. This is a valid criticism and we hope to overcome it by first leading the student to the point where we hope he has learned to walk and then by letting him loose on a problem of his own. Because of our great numbers these problems must be library problems rather than laboratory problems, but this may not be a serious matter. It is possible that we can direct students into social problems concerning the effect of science on humanity and thus fulfill not only the objective of developing critical thinking

but also effect some transfer from the laboratory to the social situation.

Another variation from the structured problem situation is the analysis of scientific reports. So far we have done this in a few classes only, but next year we expect to do it in all classes. We also intend to try the Harvard Case History approach for one or two selected areas. These case histories attempt to exemplify the tactics and strategy of science by means of historical accounts of the development of certain discoveries.

In as much as the laboratory or problem centered approach to our subject is paramount most of the classroom time is spent in the laboratory. We have a total of five classroom hours per week. Four of these hours are reserved for laboratory work or for discussion that stems from that work. One hour is for lecture.

Up to the present time I have spoken for the most part in generalities. From this point on I would like to describe specifically the nature of our course. As our conversion to Natural Science has been very recent, some parts that I will describe are in the planning stage only. But this is not true of the entire course. We have had general education courses in both the physical and biological sciences for the past eight years and we are leaning heavily on that experience.

The total course in natural science covers one academic year divided into three terms.

The first term starts with an introduction to man's learning process. We point out that empirical trial and error methods form the basis of this process; that primarily the process is concerned with learning to identify objects or things in nature and to know the relations of those objects and things. Furthermore we emphasize the use of symbolization and show its relation to human knowledge.

Our approach to man's learning process and thus to scientific method is basically behavioristic in that we assume that scientists do something when they investigate and solve a problem. Our task is to find out what they do and to define the method in operational terms.

An initial laboratory study presents the student with a diagram of a house with partly drawn blinds and with a car parked beside it. The car bears the initials M.D. We ask the student to interpret the drawing in terms of the ideas it suggests to him. Because different students interpret the picture differently it is easy to separate the facts from the hypothetical explanations of the facts. It is also quite easy to show how each student brings his own past experience into the interpretation.

We next ask the student to identify several unknowns. At the present these are small bottles containing various fluids of different color, viscosity, taste, and odor. The emphasis in this task is not the correct identification of the unknowns but rather the recognition of the behavioral factors involved in making the identification. These are first the direct act of perception; second the partial recognition of the fluids because of similarity with fluids known previously. This partial recognition represents the initial guess or hypothesis as to identity and suggests the third act in the process—the test that is to be applied to check the guess. We also point out that having words available such as fluid, smell, taste, viscosity, water, oil, etc. enables the individual to think about the matter.

This introduction to method is followed by a study of reproduction. We selected this area in part because the methods used in the historical development of the field were largely empirical involving observation of objects and relations of objects and the interpretations of observations. The cell theory fits into this area, so we are able to use it to show how generalizations can result from this type of method and how such generalizations can be useful in leading to further knowledge.

While we have found it expedient to use reproduction as a vehicle we are aware that there are other areas that could serve just as well. Astronomy certainly is one such area which has an added advantage in that it would permit the demonstration of the role played by mathematics.

The next part of our course is concerned with the subject of heredity through which we introduce the use of the conceptual scheme in scientific discovery. We interpret the conceptual scheme as being a special form of generalization which is an imaginative creation based at least sometimes on a small amount of data, but which serves to make logical and understandable a large amount of otherwise isolated or confused facts or which serves to supplant an older and less adequate explanation of the facts. According to our interpretation the logical order and understanding is accomplished by the creation of imaginary things and relations which may or may not actually exist.

Before the time of Mendel the study of heredity had produced a large body of facts concerning the process. Yet no one had put these facts together into a logical pattern. Apparently knowledge of the facts was not enough. Mendel, however, created a conceptual scheme and the facts fell into place. What exactly did Mendel do? Here I recognize that it is dangerous to attempt to infer on the basis of meager data what went on in Mendel's

mind, but after making this admission I wish to attempt an explanation of what Mendel did. Presumably, Mendel's major contribution was the creation of imaginary objects or particles (the factors) that were contained in and transmitted by the germ cells and which behaved (or were related to each other) in certain ways. The unobservable objects were the factors or genes and their "relations" were segregation, independent assortment and dominance and recessiveness. The significant function, of the conceptual scheme, as I see it, is that in those situations where direct induction from observed events cannot produce a logical and understandable explanation the creation of imaginary objects and imaginary relations accomplishes the task.

The study of heredity that follows this introduction attempts to do two things. One is to show the evidence that supports the conceptual scheme, the other is to show the social implications of our knowledge of heredity and reproduction with primary reference to the problem of quantity and quality in human populations.

Sometime during the middle of the first term we ask the students to form small groups and to select a problem for investigation in the areas of spontaneous generation, cell theory, or reproduction, heredity and populations as they relate to modern human problems. During the last week of the term the students present the results of their inquiries by panel discussion. By this technique we hope to show the relationship of scientific knowledge to human problems and to effect some transfer of critical thinking from the laboratory situation to the social situation.

The second term begins with a continuation of the discussion of the use of conceptual schemes, with emphasis on the utility of imaginary particles. By first demonstrating the use of particles by Mendel we have reversed the historical sequence of the growth of the concept of particles. Whether this is an error in judgment or not we follow Mendel's particularization of the organism with Dalton's particularization of matter and step into the atomic-molecular theory. Thus the atomic-molecular theory with the related concept of energy forms the nucleus for the term's work. This permits us to go in two directions. One involves the energy transformations in photosynthesis and cellular respiration and the other involves the development of nuclear energy. Both of these subdivisions of the study of energy offer numerous examples of social impact.

The third term is concerned with the history of the earth and organic evolution. The details of this part of the course are not fixed, but the pat-

tern followed probably will be that of the previous terms. We hope that we can give the student a sufficient grasp of these areas so that he can develop some appreciation of the effect they have had on man's understanding of himself and his environment. When students come to us their understanding of themselves and the universe is largely teleological. We hope to carry them from that point through the mechanistic determinism of the past

few centuries to a more modern interpretation.

Very probably we are too optimistic and too ambitious. It may be that the course we are developing could be taught only to students far more mature than the freshmen we get. However, we are going to try. If we have to revise our objectives in light of the capabilities of our students we will do it but only after we have attempted the more difficult assignment.

## THE BIBLE AND SCIENCE

By WILLIAM W. MENDENHALL

Teacher of Science, High School, Chamblee, Georgia

"MONKEY BUSINESS is no business at all." This quotation, which has long been a favorite motto among my pupils, might apply also to any dissertation on the Bible and science. In fact, evolution has very little place in such a discussion as this. It is through science that we are being forced gradually to abandon evolution. While many Bible students are reconciling the Bible to the theory of evolution, science, on the other hand, seems to be weakening its sanctions of progressive change as a universal law—to say nothing of such change as a creative power.

The flat earth theory went through somewhat the same process. The Bible spoke clearly of the "circle of the earth" and the "circle upon the face of the waters." It also said, "He hangeth the earth on nothing." But, for ages, many religious leaders repudiated all of this in order to be popular with their contemporaries. The Bible, though it was never intended to teach science, was scientifically too accurate for them to appreciate.

But it is not our purpose here to criticize or to interpret. Our only reason for this article is to sound some harmonious notes that some might wish to hear. We would even hope that science has something to offer for the strengthening of a faith that raises life to its true values. If you are a believer—if you have seen yourself a lost sinner and have found forgiveness in the grace and love of God—certainly nothing should be said in the name of science that would detract from your faith.

As we have just said that the Bible first told of the round earth (Isaiah 40: 22 and Proverbs 8: 27) and the earth in space (Job 26: 7); so also it spoke of the cyclonic whirls (Ecclesiastes 1: 6), the source of rain (next verse), the weight of air (Job 28: 25), modern methods of research (Daniel

1: 8 to 16), the need for vitamins which can be found in grass (Daniel's story of the cure of Nebuchadnezzar), blood circulation (Proverbs 4: 23), the internal cleansing action of the blood (many places in the Bible), antiseptic treatment of wounds (Luke 10: 30 to 37), and the connection between light and life is also mentioned though the chloroplasts were then unknown.

The first explorers who planned to find the North Pole might have profited from Job 26: 7—"He stretcheth out the north over the empty place." This might have seemed incredible to the inhabitants of Palestine who knew only of vast areas of land to the north of them. But the polar explorers found, as the Bible here says, that the most northerly stretches form a vast empty place.

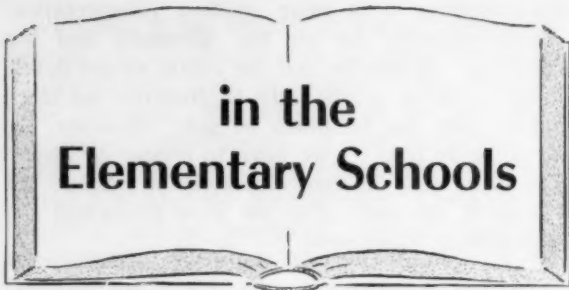
A certain oil company had enough faith in the accuracy of Bible statements to cause them to start a large research project on this basis alone. Some of its Board of Directors believed that, in the Near East, there was pitch of the right consistency to waterproof a boat for the child Moses as the Bible describes. Such natural pitch would most likely be found in or near an oil field. The result was the discovery of an immense new oil reservoir.

A Dutch ship builder had the faith to construct ships of the proportions of Noah's ark. These ships started a new era in navigation.

Though the Bible was evidently intended to teach truths and offer rewards in a realm much more important than the materials with which we work, at the same time we can not help noting that it has an accuracy, even in materialistic concepts, far beyond the philosophies of its time.

We are told in First Corinthians 15: 39, "All flesh is not the same flesh." Then some general

*(Please continue on page 95)*



## in the Elementary Schools

By **ARTHUR E. JORDAN**

**S**CIENCE TEXTBOOK NEEDS are many and varied at the elementary level. Consideration must be given to the teacher, the children, the level of reading, the course of study, the state requirements for adoption, and many other factors.

Science teaching could be improved. Preparation of teachers, those who teach all subjects and are not science majors, could be more thorough. From my observations, it appears that the classroom teacher feels slightly inadequate in the field of science, and possibly even afraid to some extent, since he or she recognizes this weakness.

This condition results in relying on the textbook as the crutch to carry on the science program. If a single textbook is used at any grade level, it soon becomes *the* course of study. This in turn limits the experiences of the children. Pupils' needs, interests, and abilities are overlooked. The scientific method gets a serious set-back since investigation, compilation, and generalization have little place in the program. There is only one authority, the textbook. Experimentation, observation, manipulation are at a minimum. Besides this, the opportunity for teacher-pupil planning is lessened. The book more or less sets the plan and the teachers and children follow.

Another serious problem arises in the use of the single text: reading. Most classes are divided into reading groups. Many schools and school systems have adopted co-basic readers so that slower learners will receive new books periodically, as do their classmates, and will at the same time not feel the stigma of "being behind" or "being dumb." This is not possible with a single text in science.

Normandy School District, in St. Louis County, Missouri, recognized that a problem existed in the teaching of science and set out to remedy the situation. An in-service class was organized. Its purpose, originally, was to broaden the teacher's background in science. It soon developed into research in resources, materials, and methods at the ele-

*(Please continue on page 82)*

# SCIENCE TEXT B

At the St. Louis meeting on Tuesday, December 30, four teacher representatives and four representatives of publishing houses participated in a symposium on needs and wants in science books and problems of producing them. A healthy exchange of experience and opinions ensued, bringing out many provocative viewpoints and implications for classroom teachers—as revealed in the three "teacher" papers on these facing pages. Next month we'll hear from the publishers' representatives.

Mr. Jordan is principal of the Washington elementary school in St. Louis County, Missouri. Dr. Goins, a member of the NSTA Board of Directors, is Professor of Science and Education at Tennessee A. and I. University, Nashville. Dr. Van Deventer, Professor of Science at Stephens College, Columbia, Missouri, has had long experience in general education science work at the college level; is very active in the work of the National Association for Research in Science Teaching.



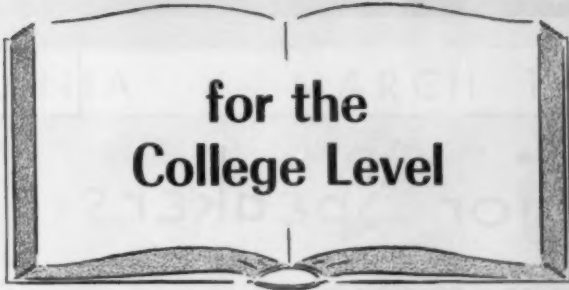
## in High Schools

By **WILLIAM F. GOINS, JR.**

**A**T THE OUTSET I want to have it clearly understood that I am a proponent of the position that an excellent textbook is an indispensable tool for good science teaching at the secondary level. By this I mean a basic textbook selected for the course and supplemented by the teacher with current materials, and not the assortment of miscellaneous books used in many secondary science courses in which the students work from one reference to another as they develop their units.

*The SCIENCE TEACHER*

# TEXTBOOK NEEDS-



## for the College Level

By W. C. VAN DEVENTER

In my personal experience, the former case has proved more satisfactory than the latter. That this seems to be generally true is supported by the opinion expressed in the Forty-sixth Yearbook of the National Society for the Study of Education that:

In general, what seems likely to prove most satisfactory is to select a basic textbook that provides a good general outline of the course and the primary text materials which all the class may be expected to study and then to supplement this foundational material with a variety of materials from other textbooks, periodicals, and reference works. (5, p. 48)

As a result of many technical improvements, most of today's science textbooks are, in general, attractive in form and style and potentially fruitful. Any one of them is likely to contain better learning materials than the average teacher is able to provide or assemble easily. Furthermore, a course based on a well-chosen textbook will possess a definiteness of sequence and continuity which is usually lacking in one which is built around a miscellany of reference materials.

Despite the continued improvement of science textbooks in recent years, however, they are by no means completely satisfactory in supporting their obvious advantage of providing for minimal essentials which should be common to all members of a class. In the subsequent discussion some aspects of this shortcoming will be pointed out as illustrations of what we want and need in secondary science textbooks.

In the time at my disposal, I shall confine my remarks to the aspects of *Content Selection* and *Subject Matter Organization*, as focal points of current weaknesses in high school science textbooks.

### Content or Selection of Subject Matter

With respect to the content or selection of subject matter found in the average high school science textbook, the question might be asked: "Does the subject matter presented make a strong contribution

(Please continue on page 83)

THE PAST TWENTY YEARS have witnessed a considerable evolution in the development and presentation of basic science courses at the college level. This period has brought the decline of the once popular survey course, and the development of "problem" approaches to the teaching of college basic science.

At the same time the vast and rapid expansion of scientific knowledge in such areas as atomic physics, astronomy, and antibiotics has added greatly to the burden of material to be learned. This has complicated the problems of basic college science teaching in that such topics have had headline value, and therefore have been much in the public thinking, so that students have had to be driven to the consideration of more fundamental factual material with even greater than usual difficulty.

These developments have made necessary a reconsideration of the type of textbooks suitable for basic science courses. Certainly the old type of textbook for a specific scientific field, which consisted of an encyclopedic collection of available information, written up in heavy technical style, with few or poor illustrations, which were in general use in beginning science courses forty years ago, are not suitable. Not much more suitable is the type of books which present a survey of several fields, with shallow penetration into any of them. As a result many teachers have worked out syllabi of their own, utilizing a wide range of available materials, some of them strictly local in origin. In many ways this is not an unhealthy tendency. It has made clear for the first time how wide are the resources for teaching, and how much a course will advantage by a teacher's being thrown upon his own devices. The process has been generally one of enrichment.

In many cases teachers have liked the idea of doing without textbooks. This tendency has continued. One teacher of basic college science says,

(Please continue on page 86)

# Highlights of the 1953 NSTA

## Major Speakers

**EDWARD U. CONDON**, *Director of Research, Corning Glass Works and President, American Association for the Advancement of Science*: "The Scientific Life in America."

**J. A. HUTCHESON**, *Vice-President, Research Laboratories, Westinghouse Electric Corporation*: "The Role of Research in the Electrical Industry."

**ALBERT J. HUGGETT**, *Associate Professor of Education, Michigan State College*: "Trends in the Teaching of Elementary Science."

**C. J. VAN SLYKE**, *Associate Director, National Institutes of Health*: "Trends in Medical Research."

**WATSON DAVIS**, *Director, Science Service and Editor Science Newsletter*: "Recent Developments in the Physical Sciences of Interest to Teachers."

**EWAN CLAGUE**, *Commissioner of Labor Statistics, U. S. Department of Labor*: "The Needs for Scientific Manpower."

**BEATRICE HICKS**, *Vice-President and Chief Engineer, Newark Controls Company*: "The Needs and Opportunities for Women in Science and Engineering."

**PHILIP G. JOHNSON**, *Specialist for Science, U. S. Office of Education*: "The Future Scientists of America Foundation."



EDWARD U. CONDON



J. A. HUTCHESON



BERNIE ARMSTRONG



ALAN

**ALAN T. WATERMAN**, *Director, National Science Foundation*: "Science for Tomorrow."

**LYLE W. ASHBY**, *Assistant Secretary, National Education Association*: "Is the Greatest Thing in Science in Danger?"

**GERALD S. CRAIG**, *Professor of the Teaching of Natural Science, Teachers College, Columbia University*: "Building the Science Program in the Elementary School."

## Panels, Symposia, & Work-Discussion Groups

**Demonstration lesson** in the teaching of elementary science

**Panel discussion**: Factors in the Teaching of Elementary Science



**HAROLD E. WISE**, *President of NSTA; University of Nebraska; toastmaster at banquet Friday evening*  
TOWNSEND STUDIO

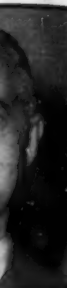
**CHARLOTTE L. GRANT**, *President-Elect of NSTA; chairman of discussion group 14*

**MARGARET E. PATTERSON**, *Executive Secretary, Science Clubs of America; chairman of discussion group 7*  
PHOTO BY SCIENCE SERVICE, INC.

**BROTHER EDWARD J. DURY, S.M.**, *Science teacher, North Catholic High School, Pittsburgh; chairman of committee on meeting rooms and facilities*

# A National Convention

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BEATRICE A. HICKS



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WATSON DAVIS

**Panel discussion:** Building the Science Program in the Elementary School

**Panel discussion:** The Fifth Year of Training for the Science Teacher

**Symposium:** "Here's How I Do It," Elementary and Junior High School Science; demonstrations and discussions by eight participants

**Symposium:** "Here's How I Do It," Senior High School Science; demonstrations and discussions by six participants

**Nineteen work-discussion groups** have been scheduled with about 120 persons serving as chairmen, recorders, and discussant-consultants. Twelve of the groups will meet at each of three work sessions.

**The Advisory Council on Industry-Science Teaching Relations;** pre-convention meetings on Wednesday, March 18, and Thursday morning, March 19.

W. C. KELLY, member of faculty, physics department, University of Pittsburgh; chairman of instructional exhibits

RALPH SCOTT, Principal, Fifth Avenue High School, Pittsburgh; chairman of registration committee

E. K. WALLACE, Chemistry Department, Pennsylvania College for Women; chairman of hospitality committee

NATHAN A. NEAL, senior editor, secondary school textbooks; McGraw-Hill Book Company; chairman of general program committee

## Other Features

**PITTSBURGH HOSPITALITY NIGHT**—sponsored by Pittsburgh industries; Bernie Armstrong and his KDKA Orchestra

### BANQUET

**EXHIBITS**—fifty displays of instructional and commercial science teaching aids

**FILM SHOWINGS**—report of NSTA Motion Picture Committee

**TOURS AND VISITATION**—schools, research institutions, industrial installations



## PRECIPITATES

### Announcements, News, and Views of Current Interest

OPPORTUNITIES FOR TEACHING with the American dependent schools overseas for the coming year have been announced by the Department of the Army. Qualified candidates will be interviewed at various points throughout the United States from February 20th to April 23rd. If you are interested in a staff position in one of these schools which are operated in Germany, Austria, Trieste, Japan, Okinawa, and the Philippines, you may obtain additional information from the Overseas Affairs Division, Office of Civilian Personnel, Office, Secretary of the Army, Washington 25, D. C.

THE SECOND ANNUAL REPORT of the National Science Foundation for the fiscal year 1952 is now for sale by the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C.—price 30 cents. Included in the report is a description of the general organization, the accomplishments of the past year, and the development of the basic policy and various activities of the Foundation. As science teachers, you will be interested in what basic research grants or fellowships have been awarded in your subject matter field or in your immediate area.

SECONDARY SCHOOL SCIENCE TEACHERS are eligible to apply for fellowships to a special summer program at the Massachusetts Institute of Technology, Cambridge, Massachusetts. The fellowships will be awarded from a grant established by the Westinghouse Education Foundation. This year's program has been designed to provide a review of fundamental subject matter in physics and chemistry together with a survey of recent developments in several of the sciences. Application forms, to be filed before April 1, are available from Professor Francis W. Sears, who is in charge of M. I. T.'s Summer Program for Science Teachers.

ARE YOU ACQUAINTED with National Parks Magazine published by the National Parks Association, Washington 9, D. C.? It presents articles of importance and of general interest relating to the national parks and monuments and is issued quarterly for members of the Association and for others who are interested in the preservation of our na-

tional parks and monuments as well as in maintaining national park standards and in helping to preserve wilderness. The photographs of the natural wonders of our country are an outstanding feature. Your school library may subscribe for \$2 a year.

A STATEMENT AFFIRMING the obligation of the schools to teach young Americans to see more clearly the face of reality in the world about them was recently published under the title, *The United Nations, Unesco, and American Schools* by the Educational Policies Commission of the National Education Association and the American Association of School Administrators. The Commission will welcome opinions concerning the statement and possible uses for it. Copies in reasonable quantities may be obtained from the NEA, 1201 16th Street, N. W., Washington 6, D. C. Free.

THE MARCH ISSUE of *Education* (Boston) is devoted exclusively to the theme: Guidance Toward Scientific Occupations. It presents articles by some fifteen specialists, both from industry and teaching, on the aspects of guidance counseling into specific occupations—as electronics, chemical engineering, outdoor education, biological vocations, teaching, and others. The articles are short, and practical.

This science education issue of *Education* is edited by Hanor A. Webb of George Peabody College for Teachers, Nashville, Tennessee, and is his sixth special assignment of this nature. Single copies of the March issue are available for fifty cents from The Palmer Company, Publishers, 370 Atlantic Avenue, Boston, Mass.

THE HIGHLIGHTS OF A YEAR'S RESEARCH at New York University's College of Engineering have been reviewed in a 32-page annual report. Included among the 74 active projects are projects in synthesizing high-energy rocket fuels, streamlining industrial plants to reduce air pollution, tracing the origin of cyclones on the east coast, and expediting traffic on the New Jersey Turnpike. Copies available on request from N. Y. U. College of Engineering, University Heights, New York City 53.

Please mention THE SCIENCE TEACHER when you write.



## "Check your air, Sir?"



To keep voices traveling strongly through telephone cables, you have to keep water *out*. This calls for speed in locating and repairing cable sheath leaks — a hard job where cable networks fork and branch to serve every neighborhood and street.

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Air compressor and tank are at right. Long cylinders on rack dry air before it enters cables.

He's checking the air pressure in a branch cable, one of scores serving a town. The readings along the cable are plotted as a graph to find low-pressure points which indicate a break in the protecting sheath.



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## CURTIS—continued from page 59

ness; or from any one of many other causes that the teacher's conscientious efforts could not counteract. But we teachers are obligated to increase our efficiency as classroom practitioners as long as we teach. Without an unremitting and vigorous effort to improve one's instructional capabilities, one's teaching must inevitably deteriorate.

12. *Since, in learning as in practically every other endeavor, an individual's most valuable assets are time and energy, the learning experiences should be planned to achieve the desired goals with the maximum economy of time and effort.* An obvious means of effecting such economies is the planning and routinizing of all phases of classroom and laboratory work such as the securing and assembling of materials and apparatus, distributing books and other materials, observing demonstrations, and viewing films. Another means is the elimination of "busy work" which in different insidious forms is not uncommon in science classes. Familiar types of busy work are requiring the learners to trace biological drawings from illustrations in textbooks; and to write up all, or most, laboratory reports in complete "story" form, even though both teachers and pupils know that the former will never have time to read, constructively criticize, and evaluate these reports.

13. *Optimally effective group learning is possible in a class, only when its members are brought to realize that participation in the class activities is both a privilege and an obligation.* In every class, there are individuals who are eager to express themselves vocally at every opportunity. There are others, often as capable as their more ubiquitous classmates, who through shyness, lack of assurance, or inertia, prefer to remain passive and to let the willing ones perform. The too-eager participants can profit from being trained to realize that "somebody else is entitled to a chance," and that mere talking is not synonymous with contributing. On the other hand, the reticent and retiring ones can gain much if they can be convinced that they owe it to themselves and to the other members of the group to participate to the best of their ability. Every teacher knows that the members of neither group can easily be brought to the appropriate con-

viction, and to govern their behaviors accordingly. But to the extent to which such training can be effected, it is of unquestioned value for present and future daily living.

14. *Effective teaching is achieved through the use of a variety of materials and procedures.* Psychologists affirm that we become defeated not so much by continued hard work, as by the monotony of unvaried work. In colloquial terms, we become tired of, more readily than we become tired by. Hence there is some basis for the extreme assertion that the best teaching method we know becomes the poorest method, if we use it exclusively.

The results of an unpublished study by the late Raleigh Schorling revealed that the attention of pupils in the seventh and eighth grades could be held unwaveringly upon an unchanging element of class procedure for an interval of only from three to six minutes. These findings are not to be interpreted as indicating that continued learning during an entire class period is impossible without a marked shift of activity every few minutes. The absurdity of such an interpretation is patent. Even if some teacher should devise as remarkable a series of changes, such a kaleidoscopic presentation would result in distraction, not concentration. It is possible, however, and often wholly desirable, to make a distinct change of activity once, or perhaps twice, during a class period. Such changes might appropriately include shifting from a general discussion, to an observation of a demonstration, working on individual problems, or performing individual experiments, reporting upon projects, carrying on directed study in groups, or taking a test.

These, then, are some of the principles that may serve as guides in bringing about effective learning of science. To the extent that they may be deemed acceptable, sound and practicable, they merit implementation and general application. The implementation of some of them, however, is still an assignment of almost insurmountable difficulty. But this difficulty is a challenge that cannot be disregarded. He who invents a successful means of implementing or of improving any of these or other principles of teaching earns an accolade for having made a significant contribution to education.

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## STRAHLER—continued from page 60

the intricacies of making the card file with cross-references. He came in extra periods to work on it.

2. Sometimes we let students teach. Superior students will do plenty of extra studying to teach the class. It often perks up interest in a less exciting lesson to have a student teach it.

3. Science book reports hit them all, too. We put our reports on cards. Students state how difficult the book was to read, how it compares with other books on the same subject, who might particularly enjoy the book. A committee of two superior students spends spare time separating good reports from poor ones according to pre-set standards. The good ones are filed and kept for free use by students interested in selecting a book to read. It is quite interesting after several reports to find differing opinions on one book.

4. We have magazine programs. They are fun and fit exceptional and normal children alike. I save my old science magazines. We pass them out, give a certain length of time for finding an interesting article. Chairmen are chosen who circulate about the room getting students' names with their article topics. Then we have a program, the chairmen introducing the speakers. Sometimes retarded students make good chairmen.

5. I'm always looking for interesting ways to review. A favorite is spending a period letting the students make up questions for review. The answers must be included. First the class has to be prepared—coached on how to pick out the important principles studied, how to organize pertinent questions. Everybody likes to do it and the superior students are intrigued by it. Then another period is spent using the questions either for a written "practice test" or for an oral contest between the girls and boys. The slowest student loves to keep score at the board. The superior ones like to give out the questions. The author of each question is revealed. Once we took all the girls' questions and gave them to a superior girl and all the boys' questions to a superior boy. Over night these two students selected the best questions to make two single lists which were given as written "practice tests" the next day. After they scored them each student wrote on his paper which was the best test and why. The vote was counted. Anyone who failed to state a legitimate reason lost his vote. It was fun, effective as a review, and the only difficult part for the teacher was in preparing the students properly at the start!

6. After we have discussed the meaning of scientific thinking and the value of experimentation, we

assign a few simple experiments to be done at home and written up in proper style. The candle and tumbler in a pan of water; the determination of relative kindling temperatures are examples. Then the students are put on their own to look up or think up experiments to try at home. Our library has several good books for this purpose. The students end up with folders of experiments—some containing a few, others containing dozens.

7. Slow students are motivated and taught by taking care of the bulletin board, bulletin board contests, preparation of notebooks, preparation of displays, help with demonstrations, care of an aquarium. My slowest learner one year spent hours after school caring for an aquarium and a terrarium in our room. He learned a lot about tropical fish; he read about them, too; and he kept the fish successfully over the summer for us.

8. I've left projects until last because I think they are most important in reaching every level of achievement. A retarded child usually enjoys making several simple projects. The superior one starts on something complex and makes it even more complex before he stops, if he ever stops. Some like to work alone, some in groups. Many get their dads and even their mothers to help them. The retarded student will probably use the teacher's suggestion for a project. The superior will think up his own. Students will give each other ideas and help. Projects develop the sense of accomplishment in every level.

Deliberately planning efficient ways of teaching will result in huge savings of time and energy for the teacher eventually. Moreover, it will result in lifted morale, a real sense of accomplishment, joy in one's work. If one cannot find the "joy of teaching" it may be because of insufficient pre-planning, not enough "capital" invested. Again it may be due to an uncooperative administrator or school system. Or it may be due to neglect of fighting for one's rights. As long as we permit ourselves to be burdened with extra-curricular activity, entirely divorced from the curriculum, we are sunk as far as chance for professional growth is concerned. I am not overlooking the value to pupils of experiences in "extra" activity, nor of the school spirit developed. But unless special time and attention are given exceptional children they will not be able to contribute to society, will not be happy, may even become burdens to others.

As I search for ideas to enrich my teaching I constantly fight for the proper conditions for this enrichment. The school, the school system, and the community, along with the teacher, must provide a squarer deal for ALL students.

## THAMES—continued from page 61

be accomplished in horticulture as well as in one of our more common science courses.

In my teaching of physics, I try to teach in full recognition of the philosophy of our school as well as the personal needs of the students. I have spent many hours working on my personal reasons for teaching and from this consideration I have in mind always the desire to do all I can with my abilities to help the students I come in contact with attain the goals they have set or are setting for themselves. I try to use every conceivable means of finding the present interests of the students at the beginning of the year. The first and logical means of finding an answer to this is to have the students write out why they are taking the course and what they want from it. This must be a serious consideration. Here is another place for expression of another Curtis principle—that of the students having both a privilege and an obligation in the class. I keep the students' papers in a file which I maintain for everyone.

Next I ask each member of the class to clip from newspapers, articles with reference to physics that they consider personally interesting. I sort these, select 30 to 40 representing as wide an interest as possible, and number each article. The next day I have the students write on a sheet of paper the same numbers of the articles we have. The articles are passed out and rotated during the hour. As each student reads an article he writes a line of comment about it. The papers are turned in. By the next day the students will probably recall the most interesting and forget the rest; at least I hope so. Now the students are asked to take another sheet of paper and list the three or four articles they personally enjoyed the most—and why. This gives me an idea as to where in the field of physics they have the most interest.

I also use standardized tests to find out where they have the most factual information as well as where they are weakest. I try to make continual checks on what has happened to the students who have graduated and which ones have actually used their high school physics for preparation for a vocation. This, I have found, turns out to be a small fraction. Therefore, I try to teach a course with emphasis on general education values and then give personal help to the five per cent, or less, who actually use physics for next-step needs.

In emphasizing the general education approach I find it necessary to discuss points related to democratic procedures, moral or ethical problems, and the like. No matter what the student works with,

he cannot isolate himself from these problems and why should we attempt to teach a course which forgets these? I have found, too, that students appreciate your interest in their problems and it helps to build the courses you teach if the students know you as being considerate of their problems and not always concerned only with the subject.

Now on my second point—that of trying as many new things as possible each year: Physics offers a wealth of these as it is impossible to cover the course in one year with the material in our text. One of the approaches I use is a project required of each one of my students. I am convinced that projects can be one of the best parts of a science course under the present day requirements of teaching subject material and the individualized instruction possible from them. It is of the utmost importance to set up a definite purpose for using projects. For example, each year I decide what changes in purposes I will make before we start the projects. Right now I am using the following purposes: to convey occupational information, to develop problem-solving procedures through collection of data and controlled experiments, to improve library usage, and to provide for self-expression.

In our projects there are three parts to the report: a paper, drawings or illustrations, and a model. As each student begins his project he is asked to explain what he is going to do and why, and to give a summary of background information necessary to do the project. In reporting, he must give details of how he went about solving his problem, the information collected, and the results or conclusions drawn.

Still another thing I do to keep interest alive and prolong memory of certain facts and ideas is through what I call my "Tricks of the Trade" cards. I have a collection of 125 or so 4 x 6 cards on which I have listed some items to use in demonstrating, fixing ideas, etc. For example, "Roy G. Biv" for remembering the colors of the spectrum; putting a dime into a cup without touching either one, for illustrating Bernoulli's principle; riddles that require analysis of words; using dry ice and acetone to lower temperature to change the characteristics of materials. One or another of these cards can be pulled and the idea used almost every teaching day of the school year.

In closing, then, it seems to me that in order to keep science in the place it should be in our schools it will be necessary to have a teacher who has a purpose for teaching science and is not there as a means of filling up his class load. And a teacher who will continually try to find a better way to do the job assigned to him.

## KLINGE—continued from page 61

in the class; and (4) students who show some especial aptitude in science as revealed through hobbies or special interests.

From this total list we select enough students for one class for the spring semester of biology, labeled "Special Biology Class." Each student is asked for his consent to be included in the class. This procedure and the usual conflicts in program making keep the group close to average class size.

The curriculum of the special class includes the same sequence of topics as in all the other biology classes. However, much of the drill work and paper work so unnecessary for the really gifted student is eliminated so that there is a surplus of time for each unit. With this time the student is asked to pursue a semester project which is a real scientific investigation, not just an intensive library-research exercise. Every science teacher in the school gives the class a lecture on a topic which ties his subject to the unit being studied. Speakers from the outside are also used, and the caliber of their contributions has been uniformly high. Grading requirements for the special class are the same as for all other biology classes. This is done

to silence the complaint that the special class is too hard and too exacting in its requirements. Many superior students would not like to risk the loss of a good grade in a special class when it might come rather easily in a regular class. Especially is this true when the colleges base so much on academic records.

We carefully check all science majors as to their progress throughout the remaining years. Each student is encouraged to find one science teacher who will act as his advisor, not only in academic and vocational information, but as a sponsor for a project which we think he should be pursuing in his high school career in science. The head of the science department, Mr. Virgil Heniser, heads this program of follow-up. We cannot force any student to do any of these, so that our job has been one of salesmanship—selling the vocations in science, selling the desirability of certain training for such vocations, selling the advisability of pursuing a high school course that may lead to scholastic aid in college.

One of the first lessons in dealing with the superior deviates is to recognize the inadvisability, even the impossibility, of forcing them into any course of action which is not required for the aver-

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age student. This is the eleventh point of Dr. Curtis's list of basic science teaching principles, in which he insists that effective learning is possible only when the learner sees that the program he is in is a privilege and an obligation. Far too many ambitious programs for segregating the superior students or even the retarded students, and giving special instruction with special requirements have crashed on the rocks of student unwillingness, parent resistance to special labels for their children, and the rather strong inertia among teachers to anything that is different from the average. It is mandatory to "sell" the program for the deviate learner to the school, to the rest of the faculty, to the students, and to the parents. When the program gains prestige, and when the personnel involved, from student to teacher, are convinced that it is valuable, the results will be amazing.

The second lesson that we have learned is that the superior student is interested in and needs a continuous evaluation of his role in science. The grading system must be such that he may see precisely how he is being evaluated, so that he too may enter into the process. The point system is excellent for this purpose, because the "A" student soon sees the differences among the "A" students, and each finds himself competing for the highest group of "A's". Too, there needs to be a continual explanation of how evaluation may be made from an analysis of the unit tests. In this way the superior students, who are vastly interested in the subject anyway, will evaluate and ask for other evaluation of their weak and strong points. This evaluation should include an account an explanation of how learning takes place so that self-examination can be used to improve the learning process, which may also be a deviate one.

The third point is that the superior student must be helped to develop a critical attitude. Scientific methods imply scientific attitudes. Too often, the superior student, whose powers of memory are usually great, accepts too much at face value. To develop his critical faculties, to carefully examine all conclusions, whether his own or from others, is a *sine qua non* for the budding scientist. When he begins to be critical, he begins to have questions. When he has questions, problems appear for his consideration. When he attempts to solve these problems in a critical manner he has achieved scientific success.

Fourth, we have discovered how much the superior student is interested in the theoretical aspects of the subject at hand. This preoccupation with the theoretical outlook on science is easily seen in the great interest shown in science fiction

with its imaginative treatments and its insistence on the theoretical being made possible. College textbooks and current science literature are good sources of current theories which can be presented in the course. These are very stimulating to the imagination of the superior student. Class discussions of scientific research with some emphasis on the hypotheses proposed offers good exercise in a careful analysis of theories.

Finally, there is the problem of identification of the superior students in science. It is quite obvious that the student with an IQ of over 135 offers wonderful potentialities. But these are not common. Are there students who may be classified as superior science students with IQ's below that? Our answer is a vigorous affirmative. Students with IQ's between 110 and 120 often show greater interest and ability than those in the 120-to-135 group. If there is a test we would like to use it; the verbal emphasis in the IQ test may not identify the superior student adequately. Teacher recommendation we have found to be a highly satisfactory method of identifying superior students. After all, identification is possible when the student is helped with an enriched curriculum, and he responds to this help. The student is identified to himself and to the teacher when the response is such that he goes several steps further than necessary. This is a pragmatic approach, but the real potential scientist must be independent in his work and show real interest in it. No matter what the IQ, if the student does not respond to the extra help then he is not the potential scientist. Identification is a matter of response to enrichment, and the teacher is the best judge of that.

In Dr. Curtis's keynote speech, the basic principles of science teaching he enunciated concern the deviate learner because many of the principles apply to the learning of the individual student. When we are ready to approach the student with an idea of discovering how he may best develop his potentialities in the field of science, then we are indeed ready to teach the deviate learner. But if we insist on a careful molding of these students to the orthodox pattern of learning, either on the insistence of the colleges or by the community, then we will not be prepared, mentally, to deal with the deviate learner.

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THE FOURTH ANNUAL Earth Science Conference in New England will be held at Salem State Teachers' College in Salem, Mass. on March 21st. This year's program will emphasize the elementary school level. For additional information write to Dr. Wroe Wolfe, Boston University, Boston 15, Mass.

## JORDAN—continued from page 70

mentary level. Not only did the teachers find out "about" things scientific, but where to locate specimens, where to find supplementary classroom aids and how to use them. It's in this field that industry is taking the play away from publishers by providing free and inexpensive materials on a myriad of subjects.

Sessions of this class were devoted to:

1. use of radio and television in teaching science
2. minerals and practical means of identifying them
3. birds, their calls, habits, and identification
4. things to look for in nature through the seasons
5. how to make simple inexpensive laboratory equipment
6. textbooks and other written materials
7. how to make slides and simple projectors
8. the project method, when and how it should be used
9. articulation through the high school in the field of science
10. grade placement of subject matter
11. conservation and services provided to schools by the commission

The course was supplemented with field trips to a forest and game preserve, a national park, and a meeting on preparation for a science fair.

The reason for mentioning the course at all is that out of it came some conclusions which affect the book publishers.

1. The basic text has a place in the program as a guide to the experiences of the children of any grade level with suggested activities, experiments, projects, and observations which would carry the children outside the text or classroom. In this manner individual interests, abilities, and needs would not suffer.

2. Additional texts should be provided at various reading levels so that investigations where factual recorded knowledge is needed could be successfully located, through teachers' guidance, if necessary, by all pupils. All pupils could contribute and the use of the scientific method would be advanced.

3. Teachers would need assistance in use of the multi-text approach. A simple guide to building classroom or school libraries could be compiled to help in this matter. All books containing scientific information could be classified as to subject and reading level. With this volume, many of the teachers' problems would be solved.

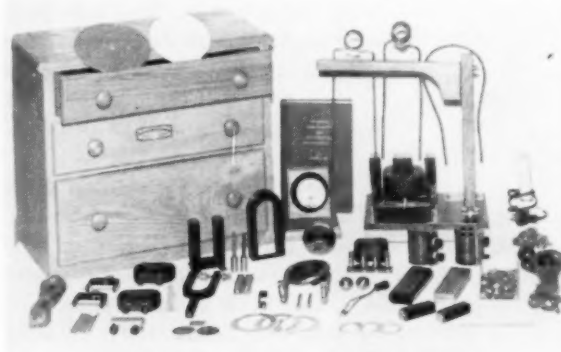
4. Textbook publishers must realize that although experts have logically arranged subject matter by grades, not all children are ready for the same experiences or information at the same time and in the same way within the same grade level.

Also, that all children have interests in common about some things regardless of grade level. At present, television, jet airplanes, and outer space occupy this unique position.

5. Publishers must realize, also, that the greatest resource persons in the field of science are the pupils. They will bring specimens of all descriptions to class at the slightest provocation and sometimes without solicitation. They are insatiably curious. The time to answer their questions is at the time they are asked. The answer then has meaning. When a child asks the teacher, "What kind of rock is this?", "Why does it rain?", "What makes day and night?", the teacher has to know the answer or be able to direct him to a source that he can read and understand. Thus, regardless of the level at which the question is asked, reference material should be available.

It is recognized by educators that the publishing of texts and references is expensive. Also, that texts are improving in appearance, readability, and illustrations. Research behind them is thorough. The need seems to be for increased amount of material, broader in scope, and available to teachers and children of all levels.

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## GOINS—continued from page 71

to all subject objectives?" A more subtle way of putting the same idea is to inquire of what basic value is the material. In far too many instances of science texts in current use, the answer to the original question is "No"; to the second, "Very little." Why these answers? Let us first look at the basic philosophy and objectives of science teaching. These were summarized in the Forty-sixth Yearbook, previously referred to, as follows:

Science teachers have a great opportunity and responsibility to make a large contribution to the welfare and advancement of humanity . . . Science is a great social force as well as a method of investigation. The understanding and acceptance of these facts and this point of view and their implementation in practice will, more than anything else, make science teaching what it can and should be. (5, p. 39)

Few science textbooks reflect in their content the social responsibility of science education. It is a bold author indeed who will take a firm stand in his textbook in the area of values, or who will try genuinely to relate his science to social problems. In such cases most of our science books border on insincerity. Science textbooks all but ignore hunger, cold, noise, stench—on the grounds, perhaps, that such things are outside the domain of science. Typical science topics like *alcohol* and *sex* are handled very gingerly, with tongue in cheek, by most authors. A few years ago, while investigating published textual materials on the effects of drinking, Anna Roe (4) found such material in textbooks on health, general science, biology, and chemistry, among others. In the general science and biology books, the emphasis was mainly on the personal aspects of heavy drinking, with an occasional reference to alcohol and traffic accidents, or to alcohol and crime. Since the emphasis in general in these texts was mainly on how organisms, especially man, cope with their environments and satisfy their needs, one would expect that a more rational approach to alcoholism would be made from the standpoint of nutrition, but this was not done. Even a textbook which mentioned the subjective effect of alcoholism on driving neglected to discuss chemical tests for alcohol in the body.

This "head in sand" attitude of some textbook authors is decried even by textbook publishers. An official of one of the publishers represented here today had this to say not too long ago:

References to sex in high school textbooks are disgraceful examples of reticence masquerading as candor. Either we should let

adolescents learn for themselves or from one another, with all the risks of a *laissez faire* policy, or we should be honest. Every adolescent knows, and no schoolbook for adolescents acknowledges, the power of sexual temptation. The textbook which plays down the psychological side of sex, talks primly about sublimation and the expediency of monogamy, is despised by the youthful reader. (2)

Fortunately it is not perversity or lack of insight which causes our textbook authors and publishers to walk softly on controversial issues, but merely bending to the whims of a potential market. To them economic common sense seems to demand that their textbooks remain innocuous and rather general. They fail to realize that these books also fall short in contributing to one of the basic objectives of science education.

What we need then in respect to content are high school science textbooks that will present important facts and generalizations necessary to meet the intellectual and material objectives of science education boldly and sincerely. This subject matter should be enlivened by correlation of facts and principles with human activities and progress and centered around problems of deep human concern.

### Organization and Presentation of Content

While it is recognized that no specific selection of content or arrangement of subject matter will completely meet the objectives of science teaching—method having an important contribution to make—thoughtful organization and presentation of content exert a great influence on their attainment. This is especially true if the problems and understandings of science are so organized as to direct their use to the solution of socially significant questions, with continued reference to the interaction between scientific development and social change.

Important questions bearing on the organization and presentation of subject matter center around:

1. the achievement level of the learner
2. psychological sequence
3. provision for individual differences and personal needs.

Clearness of presentation of subject matter must be judged in the light of the achievement level of the learner. In this respect, many of our secondary science books are still too complicated to be really worthwhile, as evidenced by the vocabulary they contain. Despite the extensive vocabulary investigation conducted by Curtis (1) in 1938, and the considerable progress made in remedying the

situation he reported, Mallinson (3) found quite recently that evidence indicates that many textbooks in science are still likely to cause difficulty for students in the courses for which they are designed because of the vocabulary load. Mallinson suggests that the publishers constantly check the levels of reading difficulty of the textbooks, trying to minimize the technical vocabulary and the difficult non-technical terms. Where such terms must appear in the textual material, it is desirable that they be explained carefully and then used in several contexts later on so that the student may generalize the meanings. The point to bear in mind here is that the mastery of a technical word in science requires the mastering of a concept and not simple memorizing of a definition.

Apart from vocabulary difficulty, a second weakness of science textbooks emerges when presentation and organization of textual material are examined for psychological sequence. Much textbook material is often presented in such a manner as to be hardly clear to the average or bright student.

In far too many cases important principles are developed with much more emphasis on logical than upon psychological development. Modern educational psychology has established fairly definite laws of learning by which important facts and gen-

eralizations are developed and mastered. Mastery of facts and principles usually involves beginning on the level of learning of the student and then proceeding through a working-out of essential relationships to a final realization of generalizations, and their application in life situations. Modern educational method recognizes the equal importance of both the inductive and the deductive methods of teaching. Unfortunately, many of our science textbooks emphasize strongly the deductive approach, with unit after unit opening with a statement of law or principle, followed by verification and application.

A third important area in which science textbooks still need improvement might be considered by some to be more properly placed under choice of content, but will be considered here under organization and presentation of subject matter. This area deals with provisions for individual differences and common personal needs of students.

Textbook authors and publishers accept the principle that our goal is to teach children, not subjects. They recognize that children differ widely in abilities, interests, and aspirations; that young people need sympathy, tolerance, and physical, emotional, and intellectual security. Yet when the science textbooks are produced, these books fall short

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in developing an understanding of those factors which make for unity and those which make for diversity within our society. The books show that the teacher still has much to do to develop understandings of human beings and their interrelationships where science impinges upon them.

The average student wants the security of understanding things for himself. He wants to know how ideas fit together, what his role is in society, what his capabilities and limitations are. In short, he wants things to make sense to him. Far too many of our science textbooks fall short of this goal. They fail to recognize the wide variety of socio-economic conditions and ability groups found in the average classroom. As one writer puts it, they presuppose:

the reader to be a native-born child of a middle-income family of Nordic extraction residing in the Northeast. By inference we fail to accept the Negro, the Mexican, and the Puerto Rican as basically and normally American . . . /also/ that all the children of a class recruited from all ability groups can do everything required in the book . . . (2)

Many science textbook authors are still content to provide a summary of facts or an explanation of processes and principles, rather than rounding out ideas, relating one idea to another, and helping the student build on what has been previously learned, with the ultimate goal of building understanding and the stimulation of creative thinking. Of course, one does not expect the author to include all applications of an idea or even follow at length each pathway of thinking which might be opened, but he can provide a point of departure on a common basis of thinking. Some of our best books already do this by including thought questions, exercises in critical thinking, and extensive bibliographies for those students who wish to delve

deeper in some phase of a problem raised in the context. Such books are so organized and written as to stimulate students to push on a little farther.

### Summary

Although the two aspects used to point out needs in high school science textbooks have by no means been exhausted, a few points have been suggested and certain implications seem evident. Hence the following recommendations are made with the view toward suggesting what we want and need in the textbooks:

1. That high school science textbooks increase their emphasis on the social responsibility of science while continuing their emphasis on science as a method of investigation. This might be done by frankly and sincerely correlating science facts and principles with human social problems.
2. That textbook authors and publishers increase their efforts toward minimizing the level of reading difficulty of science textbooks through reduction of frequency of technical terms and difficult non-technical terms.
3. That textbook authors employ more of the inductive approach in their writing, making a greater effort to approach material from a psychological rather than a logical sequence.
4. That textbook publishers and authors give wider recognition to the different socio-economic and ability groups that will use their textbooks. In their examples and illustrations of facts and principles, a wider range of economic, sociological, and anthropological cases might be used.
5. That textbook writers should increase their efforts to round out and relate major ideas, then provide exercises and devices which will encourage the development of critical thinking on the part of the users.

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## VAN DEVENTER—continued from page 71

"Oh textbooks: I don't use them! What they lack is the flexibility of conception that would support a course characterized both by genuine inquiry (intensive rather than survey-superficial) and largely student-determined in content and sequence. Also in exposition, they are self-defeatingly taciturn—where a readable book (not a text) would expand and illustrate and define, they state, say a Newtonian law, once, compactly, and hurry on to 'cover' all the traditional welter of topics."<sup>1</sup>

Another teacher says, "I have gotten to the point where I would not have a textbook if it were not that members of my department who teach the same or similar classes want one and feel they need one. Why would I not have a text? I have found them inadequate for my needs: (1) They are subject-matter oriented. (2) They have little or nothing in them that deals with what we mean when we say that we want our students to realize how a scientist works and the kind of things that he does. (3) Texts are generally lacking in developing the historical setting out of which our modern day concepts have arisen. Nor do they include the developmental stages that man the scientist has gone through or struggled with in arriving where he is. (4) There is a lack of material that draws the attention of the student to the way that a scientist thinks. (5) The scientific method may be dealt with in some texts, but it is taken care of inadequately. What I would like is to have *all through the text*, wherever the opportunity presents itself, the use of science materials in such a way that they would be illustrative of the different aspects of the scientific method and the way that a scientist thinks and works. (6) I would like also to have texts give the student the feeling that we have not necessarily 'arrived', and that 'this is it', but rather that *here we are* because of our past ways of thinking and working, and that *here are the possible directions* in which we seem to be going, and *here are some of the implications* that have to do with man's changing life and thinking."<sup>2</sup>

These indictments of available textbooks serve to point up some of the needs which teachers generally feel should be met by such books. It is highly probable that textbooks are really not desirable or necessary for certain types of courses. The writer has not used a text in his own teaching of basic science courses for fifteen years, preferring

instead to prepare his own syllabi and utilize a wide range of materials, including particularly those of the local community, which has served his classes as a field trip-laboratory area.

Incident to the preparation of the present paper, the writer asked a number of teachers of his acquaintance to prepare statements of what they considered to be the most desirable characteristics of textbooks for use in basic science courses. The statements which have just been quoted came from two of these sources.

In greater numbers than for anything else these teachers asked for textbooks written in easily readable, non-technical language, supplemented by adequate glossaries where necessary. Careful studies on level of reading ability have shown that many of our college textbooks are written beyond the level of the vocabulary of the students whom we expect to read them. Writing material at the student level does not necessarily mean that we "water down" the ideas that are presented. The accurate and careful reporting of facts and ideas of science in the science section of such a magazine as *Time* shows that there is no need for this to be so. As Dr. W. W. Charters once told the writer, what we need to do is to "express million-dollar ideas in ten-cent words." Of course some technical vocabulary is necessary. There is no thought that we should simply leave the student where he is, so far as vocabulary is concerned. Words are often the keys to ideas, and the presentation of new ideas may demand new language. Careful explanation of meanings in context is the best way to accomplish such broadening of vocabulary. A good glossary, however, serves as a summary of such language expansion.

Another need expressed by the teachers was for better use of illustrations. In this respect modern textbooks represent a vast improvement over those of even twenty years ago when the writer was a student. Better methods of pictorial reproduction, as well as a realization of the need for more illustrative presentation have contributed to this development. Nevertheless there is still room for improvement. The popularity of "picture magazines" such as *Life* and the development by them of the technique of the "pictorial story" present a challenge to textbook writers. This is being met in some cases by the use of motion pictures designed specifically to accompany and supplement a particular text, but it seems to the writer that there could be a greater use of something like the pictorial story technique within the text itself.

A large number of the teachers who were asked expressed a desire to see greater attention given to

<sup>1</sup> Loud, Oliver S., Antioch College, private communication.

<sup>2</sup> Sundquist, Leona, Western Washington College of Education, private communication.

the major concepts and ideas of science, with specific attention given to the application of these ideas to new situations, to further thinking, and to the everyday science experiences which occur in the world of living. Of course this is a large order. Nevertheless a growing realization on the part of teachers of the utter impossibility of adequately "covering the field", so far as facts are concerned, in any basic course, has forced them to a consideration of what is really fundamental. It appears on such consideration that there are certain major ideas that are common to all of the areas of one science or of several or all sciences. An emphasis on these and on their everyday applications as well as their "pure science" aspects is more meaningful to the student than any number of bare facts.

Along with this desired emphasis on major ideas is the related emphasis on scientific method and attitude. Laying aside all arguments as to whether there is one scientific method or several related procedures which can be called scientific methods, it appears that there are certain kinds of things that a scientist does in connection with the uncovering of knowledge, and certain points of view which he assumes that are common to all fields of science. After all, the activities and attitudes of the geologist, the biologist, the physicist, the chemist, and

the astronomer, and possibly also the psychologist and the sociologist, are expressible in much the same language. The verbalizing of such procedures and attitudes in language that the general student can understand, and the pointing out of every-day applications of them, is a job that the textbook writer may well undertake.

The development of the "block-and-gap" type of course, where a few carefully chosen units are penetrated deeply, rather than attempting to cover wider areas more superficially, has brought some division in thinking among teachers of basic science. Not everyone is "sold" on the "block-and-gap" type course, although its enthusiasts extol its virtues with great sincerity and much effect. Proponents of this type of course stress the understanding of scientific method and attitude which students obtain from it, and deny that there is any great deficiency in either facts learned or broad understandings of specific fields. They would like to see more books written which would consist largely of original papers or excerpts from them, together with modern presentations of problems in the authors' original words or careful editings.

On the other hand there is still a strong sentiment for the exact opposite in the way of textbook writing, with carefully integrated rather than discrete units. This is in no sense a harking back to the survey course idea, but rather an extension of the desire to implement the great underlying principles on which all science is based.

In connection with both types of books a great desire is expressed for the inclusion of lists of references which the teacher may use to supplement the learning experiences made available within the text itself. The proponents of the "case study" method have certainly made all teachers more conscious of the need for going behind the textbook statements, both for the purpose of giving a broader basis for the necessary summarizing of materials within the text and for giving the student some understanding of how scientists arrived at the facts that they present.

The present time is a time of broad experimentation in methods of basic science teaching. This is a healthy state of affairs for the future of science teaching, even if it also tends to be the despair of textbook writers. The writer of this paper, however, does not despair. He believes that it will be possible to develop textbooks which will fit the needs of new types of courses as they arise. The encouraging thing, of course, is that it is the teachers themselves who develop the new ideas and who also write the books.

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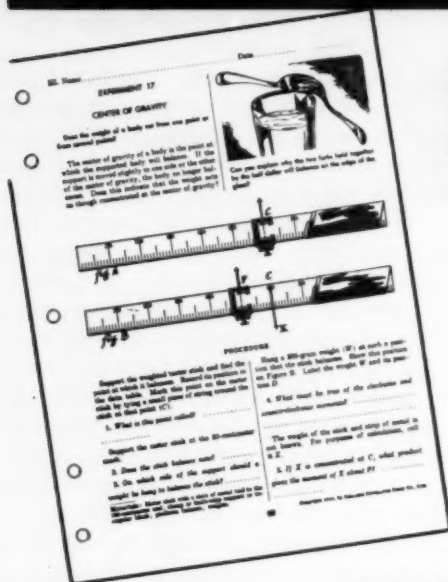
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# NSTA Activities

## ► Constitution Revisions Proposed

The constitution of NSTA was last revised in 1950. During the past two years certain operational problems developed which were studied by special committees, by consultants, and by the officers of the Association. At a meeting of the Executive Committee at the St. Louis conference December 28, 1952, three proposals, each involving changes in the By-Laws and one also involving a change in the Constitution and the Governing Rules, were recommended for submission to the Board of Directors by mail and to the members of the Association through THE SCIENCE TEACHER. These proposed revisions are as follows.

I. The Constitution provides (By-Laws, Article IV, Section 2) that "Officers and directors shall take office August 1." It is proposed that Article IV, Section 2, of the By-Laws be changed to read:

*"Officers and directors shall take office at the conclusion of the annual business session of the Board of Directors."*

It is current practice (as provided by the Governing Rules) to hold the annual business session at or near the time and place of the NEA meetings in late June or early July. Adoption of the proposed change would do away with the "lame duck" period, during July each year, before newly elected officers and directors take over on August 1.

II. Article V, Section 8, of the By-Laws reads as follows: "The Treasurer shall maintain the financial records of NSTA with the assistance of the National Education Association as the official depository. He shall prepare an annual report for the general membership and such additional reports as may be required from time to time by the Board of Directors. He shall authorize payments only upon written order of the President. The Board of Directors may require a bond to cover financial transactions of officers and members in the handling of all NSTA funds."

It is proposed that Section 8 of Article V of the By-Laws be amended to read as follows:

*"1. The Treasurer shall serve as chairman of the Auditing Committee and as chairman of the Budget Committee for the ensuing year.*

*"2. The Treasurer and President shall receive monthly financial reports from the Executive Secretary and financial reports from the National Edu-*

*cation Association (the official depository for NSTA) whenever such reports are issued. The Treasurer shall critically analyze these reports, compare with the current budget as authorized by the Board of Directors, and periodically report to the Executive Committee and Board of Directors.*

*"3. The Executive Secretary shall be responsible for all bookkeeping. He shall authorize all payments of funds within the provisions of the budget approved by the Board of Directors. He shall not authorize funds in excess of budgetary provisions without specific authorization by the Executive Committee.*

*"4. At the end of each fiscal year, the Treasurer, as chairman of the Audit Committee, shall direct a thorough audit of all NSTA financial records in the office of the Executive Secretary and of the NEA and shall report in writing to the Board of Directors at its annual business meeting."*

This change would be in line with a recommendation of a Certified Public Accountant who made a study of NSTA financial operations and records two years ago and with the report of a special committee on Policies Relative to Finances and Audit (*Minutes*, Annual Meeting, Board of Directors, Oakland, California, June 30, July 1-2, 1951). Approval of this proposed revision would place the financial recording-keeping responsibility with the Executive Secretary. Association safeguards would include (a) bonding of all NSTA office employees through NEA general policies, (b) the provision that the Executive Secretary "shall not authorize funds in excess of budgetary provisions without specific authorization by the Executive Committee," and (c) making the Treasurer responsible for a thorough audit each year and for the presentation of a written report to the Board of Directors.

III. According to the Constitution, the Board of Directors of NSTA consists of: "1. The elected officers as follows: president, retiring president, president-elect, four regional vice-presidents, secretary, and treasurer. 2. Eight directors elected on a regional basis. 3. Six directors elected at large from the membership."

It is proposed that the Constitution, By-Laws, and Governing Rules be amended as needed to re-define membership on the Board of Directors as follows:

*"The Board of Directors shall consist of:*

*"1. Members of the Executive Committee as follows: president, retiring president, president-elect, secretary, treasurer, and executive secretary.*

"2. Eight directors (or alternate directors) elected on a regional basis as follows: one director and one alternate director from each of the eight regions indicated below. Directors and alternate directors from the odd-numbered regions are to be elected in odd-numbered years and directors and alternate directors from even-numbered regions in even-numbered years. An alternate director is to receive copies of all official communications sent to the director from his region. The alternate director may attend any meeting of the Board of Directors and participate in discussion but may vote only if the director from his region is absent. In the absence of a director at any meeting of the Board of Directors, the alternate director from his region, if in attendance, shall be eligible to receive any remuneration for expenses authorized for the director if he had attended.

"Region I—Maine, New Hampshire, Vermont, Connecticut, Rhode Island, Massachusetts.

"Region II—New York, Pennsylvania, New Jersey.

"Region III—Delaware, Maryland, Virginia, West Virginia, Kentucky, Tennessee, North Carolina, District of Columbia.

"Region IV—South Carolina, Georgia, Alabama, Mississippi, Florida, Arkansas, Louisiana.

"Region V—Ohio, Indiana, Illinois, Michigan.

"Region VI—Wisconsin, Minnesota, Iowa, North Dakota, South Dakota, Nebraska, Montana, Wyoming.

"Region VII—Kansas, Missouri, Oklahoma, Texas, Colorado, New Mexico.

"Region VIII—Washington, Oregon, Idaho, Nevada, California, Utah, Arizona."

If the above proposal should be approved by the NSTA membership, the specific amendments to the Constitution, By-Laws, and Governing Rules needed for its implementation are matters of detail. The Secretary of NSTA will be requested to prepare specific amendments to implement the change and to present these amendments to the Board of Directors at its business session at Miami Beach, Florida, next summer for approval "as proper amendments to implement the action of the Board of Directors and members of NSTA on this proposal."

Also, if this proposal is approved, the Secretary of NSTA will be requested to prepare a plan for the guidance of nominating committees in putting the change into effect. This plan would take into consideration the present representation of Regions I to VIII on the Board of Directors and the dates their respective terms expire. Each person now on the Board of Directors would be expected to complete the entire term for which he was elected.

Proposal III is being submitted in an effort to: (a) cut down the size of the Board of Directors and therefore the expense of meetings; (2) secure more ade-

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quate representation of all sections of the United States at all meetings of the Board of Directors; and (3) create a structure which will better facilitate choosing locations and delegating responsibility for regional meetings of the Association and other Association affairs.

According to our Constitution, amendments shall be made when (a) the proposal has been sent to the members through the official journal or by mail at least sixty days prior to the date on which action may be taken; (b) approved by a two-thirds vote of the members voting; and (c) approved by a vote of two-thirds of the entire membership of the Board of Directors. Amendments to the By-Laws shall be made when (a) the proposal has been sent to the members through the official journal or by mail at least sixty days prior to the date on which action may be taken; and either of the following requirements has been satisfied: (b) approved by a two-thirds vote of the members voting; or, (c) approved by a majority vote of the members voting and approved by a majority of the entire membership of the Board of Directors. Amendments to the Governing Rules may be made by a majority vote of the Board of Directors when a quorum is present.

The above three proposals have been submitted to the Board of Directors for a mail vote, which resulted in: Proposal I, 19 For and 1 Against; Proposal II, 18 For and 2 Against; Proposal III, 16 For and 4 Against. Since each proposal was approved by more than a two-thirds majority of the entire membership of the Board, I am requesting the Executive Secretary to submit these proposals to the membership of NSTA through the pages of *The Science Teacher*. The ballot for the election of officers for 1953-54 will also contain these three proposals in order to provide the opportunity for members of NSTA to express their preferences.

HAROLD E. WISE, *President of NSTA*

## ► Science Achievement Awards

### Program Rolling in High Gear

Response to the second annual program of Science Achievement Awards has far exceeded that of last year and is rapidly approaching the goal set by this year's operating committee, according to its chairman, John B. Chase, Jr. of the University of Virginia. Close to 1200 teachers have requested entry forms so that their students may enter the contest, which is sponsored by the American Society for Metals and is conducted through the Future Scientists of America Foundation. Nearly 15,000 student entry forms have been sent in response to their requests.

Members of NSTA can help make this program a success in achieving its purposes by sending for the 1953 Book of Rules and Information and for the requisite number of student entry forms. Then, of course, the students should be encouraged to complete

and mail their entry forms immediately and to proceed with the completion of their science projects and activities. Students who send in completed entry cards will immediately receive their Future Scientists of America lapel buttons, a reproduction of the FSAF seal in red, white, and blue.



Although the closing date for actual entries to be sent to the regional chairmen is May 31, the completed work of students may be sent in at any time. Some regional chairmen have reported that student entries are already reaching them.

Teachers, too, have requested nearly two thousand entry forms for reporting their own "best practices and most effective techniques" for stepping up the quality of science instruction in their classes. Completed teacher entries should be sent to the NSTA Headquarters Office in Washington, D. C. In addition to the awarding of prizes for the best, it is expected that a much larger number of these will be published in a 1954 edition of "Selected Science Teaching Ideas." Teacher entries in last year's program are now being edited and will soon go to press.

## ► New Members Chosen

### To Serve on Magazine Advisory Board

In accordance with provisions of operating policies for *The Science Teacher*, the NSTA Board of Directors has elected two new members to the Magazine Advisory Board for three-year terms extending through December, 1955. Chosen were Miss Archie J. MacLean and Louis Panush. Miss MacLean is attached to the Curriculum Division of the Board of Education, Los Angeles, California, serving as Supervisor of Science. She has published numerous books and articles, has been active in NSTA committee activities, particularly in areas of health and conservation education, and in the planning of the Mills College meeting in 1951. Miss MacLean is now rounding out a term as Western Regional Vice-President. Mr. Panush teaches chemistry in Northeastern High School, Detroit, Michigan. He has contributed to the NSTA magazine in this field and also in the field of the earth sciences. He has served on NSTA committees and is editor and business manager of *The Metropolitan Detroit Science Review*.

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**CORRECTION!** Instead of "Section Q (AAAS)," the explanatory note at the head of the article on page 55 should read "the Cooperative Committee (AAAS)." Our mental lapse was caught too late for correction in the engraving. Red-faced, we extend apologies.

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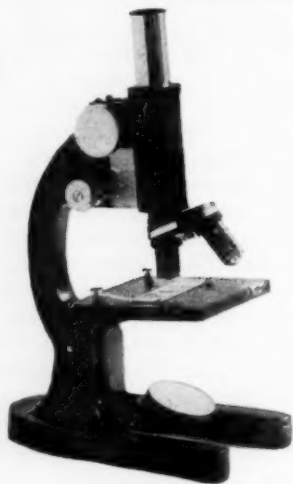
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# Book Reviews

BOBBY BLUEGILL, R. W. Eschmeyer. 48 pp. \$.50.  
Fisherman Press, Inc. Oxford, Ohio. 1952.

This is the fourth of Dr. Eschmeyer's True-To-Life Stories for children from eight to fourteen years. It is a delightful tale of Bobby Bluegill's life in Mr. Johnson's farm pond with its natural hazards of overproduction and food shortage. Bobby's luck held to the end. He escaped from the hungry bass, the fisherman's hook and the great blue heron. He was one of the four hundred bluegills put back into the pond after the necessary seining by the soil conservation man.

Woven into this interesting story, in a simple true-to-life manner, are the basic concepts of the balance of nature, the struggle for existence, and good game management. *Bobby Bluegill* is a contribution to conservation education for both city and rural children.

MURIEL BEUSCHLEIN  
*Chicago Teachers College*

GENERAL BIOLOGY. James Watt Mavor, Fourth Edition. 875 pages. \$5.75. The Macmillan Company, New York, 1952.

The previous success of *General Biology* by James Watt Mavor is being perpetuated in this edition. The text has such a wealth of material that it can be adapted to the needs of most teaching plans for this subject even in various parts of the country. The text has been brought up to date and includes such recent material as the work of von Frisch on the language of bees.

While there is a unity to this work the chapters are more or less separate, permitting changing of the order in which the chapters are studied, or even the omission of some chapters. A survey of the biota appears early in the text permitting field work to begin early in the fall while plants and animals are available in their natural habitats.

The book is well illustrated. Good use is made of line drawings and tables. Photographs are well reproduced.

The appendix is especially noteworthy. Here the plant and the animal kingdoms are tabulated, the pronunciation of taxonomic terms, and origin and meaning of the root words involved, indicated. The

glossary is handled in the same fashion which helps the student to really understand scientific terms through the Latin and Greek roots used.

The laboratory book provided for use with this text has 34 exercises of good variety with accompanying work sheets.

F. A. HANAWALT  
*Otterbein College*  
*Westerville, Ohio*

GENERAL ELECTRICITY SHOP WORK MANUAL. Fox, Komow, Hurley and others. 114 pp. Board of Education of the City of New York. New York. 1951.

Here is a work manual, not for the student, this time, but for the teacher. Aimed at the seventh, eighth, and ninth grades, the manual is intended as a supplement and extension of a prescribed course in electrical shop work.

It contains outlines and directions for (a) elementary electrical operations and techniques, such as splicing, soldering, coil winding, and making basic connections and testing them; (b) projects involving the construction of simple electrical devices, such as buzzers, motors and electromagnets; and (c) a number of exercises requiring the assembly and repair of a half-dozen electrical appliances.

The manual has at least three valuable uses: (1) as an outline for the industrial arts teacher in a large school system that conforms to a closely coordinated teaching program; (2) a guide for the new teacher or substitute; and (3) an aid to the teacher with a heavy work load.

It is a teacher's reference, not an outline to be followed slavishly, but a source-book of suggestions. There are helpful hints for using the manual, the first day in the shop, shop management, handling and sorting supplies and equipment, an excellent set of safety instructions, and a worthwhile discussion of pupil activity in the shop. Three sample project teaching plans, for both individual and group activities, are provided.

An outstanding feature is the unusually fine collection of references to source material, ideas for related activities in the shop, other school courses and community, teaching aids, and practical study exercises.

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Well written, the manual is printed by photo-offset, with board covers and a plastic ring-binding. While probably intended as an expendable, the manual stood up very well during a month's rough handling in the writer's workshop.

This represents a well organized effort to assist a teacher in motivating a class of teen-age students and helping them to "learn by doing." Finally, this manual is intended for the teacher, and is unsuitable for use as a class workbook.

Donald G. McBrien  
*Boston University*  
*Optical Research Laboratory*

DANA'S MANUAL OF MINERALOGY, Sixteenth edition. Revised by Cornelius S. Hurlburt, Jr. 530 pp. \$6.00. John Wiley & Sons. New York. 1952.

New developments and techniques in the field of mineralogy have brought this science increasingly closer to chemistry and physics. For this reason, mineralogy takes on a new perspective for teachers of secondary school science. While it is true that mineralogy, as such, is not generally taught on the secondary level, still the various aspects of the field are used to advantage by science teachers. This is particularly true in the field of earth science. With

the closer relationship between mineralogy and chemistry and physics constantly being developed, aspects of mineralogy may be used to advantage by the chemistry teacher as well as the physics teacher.

Professor Hurlburt who teaches elementary mineralogy at Harvard has done an excellent job in revising this text that has been used by students for many years. He has brought his experience as a teacher to bear in the presentation of the material. He has written the text with clarity and with the limitations of students in mind. Thus, for example; in order to orient the beginner, Professor Hurlburt has added a chapter on "Mineralogy" that defines minerals, the methods, scope and problems of the mineralogist. Further, in light of the developments in chemistry as they relate to mineralogy, he has included a section on crystal chemistry in the chapter on crystallography.

The first half of the book includes, besides the chapter mentioned above on mineralogy, chapters dealing with chemical and physical mineralogy. The second half concerns itself largely with descriptive mineralogy, a compilation of the latest data of a larger number of minerals than in the previous editions.

LOUIS TRUNCELLITO  
*Memorial High School*  
*West New York, N. J.*

## MENDENHALL—continued from page 69

cases of divergence are mentioned such as men, beasts, fishes, and birds. Many have believed and taught even very recently that the human embryo, up to a certain stage, is identical with the one-celled animals; then, through another stage, that it is identical with the chick; and, through another stage, identical with the pig. But we are now certain that, in both number and kind of chromosomes and genes as well as many other characteristics, the cells are very different; that "all flesh is not the same flesh" at any stage of its existence.

Then the statement, (Matthew 15: 20) "Eating with unwashed hands defileth not a man," has raised many questions through the centuries and has caused many critics to raise their eyebrows. But a simple bacteriological experiment shows that a light washing, such as was used in ancient times, only floats away some of the protecting oils which cover bacteria on dry hands. Such superficial washing actually releases many bacteria and so increases the danger of bacterial contamination.

In His miracle of healing the palsied man, Jesus first said, "Thy sins be forgiven thee." This is the

only healing in which this assurance was first given and it is certainly not contrary to our modern belief that remorse can aggravate and even cause such palsy and paralysis. This faith that repented sins will be remembered no more would be necessary for making any cure of this palsy or paralysis permanent.

These few examples may suggest other and better ones. If you have any, we would take pleasure in compiling them. But leaving specific examples, let us take a look at the Bible's comprehensive view of the earth in Isaiah 10: 12—"Who hath measured the waters in the hollow of His hand, and meted out heaven with a span, and comprehended the dust of the earth in a measure, and weighed the mountains in scales, and the hills in a balance!" Then we can go on to Hebrews 11: 3—"Through faith we understand that the worlds (notice the plural) were framed by the word of God, so that things which are seen were not made of things which do appear." After reading this, a chemical research director said that "no more profound statement bearing on the ultimate constitution of the *stuff* of the cosmos—what we call *matter* and *energy*—has ever come from the lips of any atomic physicist than this statement of Paul's. The world about us, far more intricate than any watch, filled with checks and balances of a hundred varieties, marvelous beyond even the imagination of the most skilled scientific investigator, this beautiful and intricate creation bears the signature of its Creator, graven in its works."<sup>1</sup> One cannot help thinking that even science might often profit from just such a check and balance as the Bible affords.

<sup>1</sup>Quoted from *A Chemist and His Bible*, Charles M. A. Stine.

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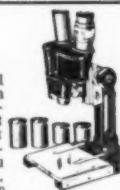
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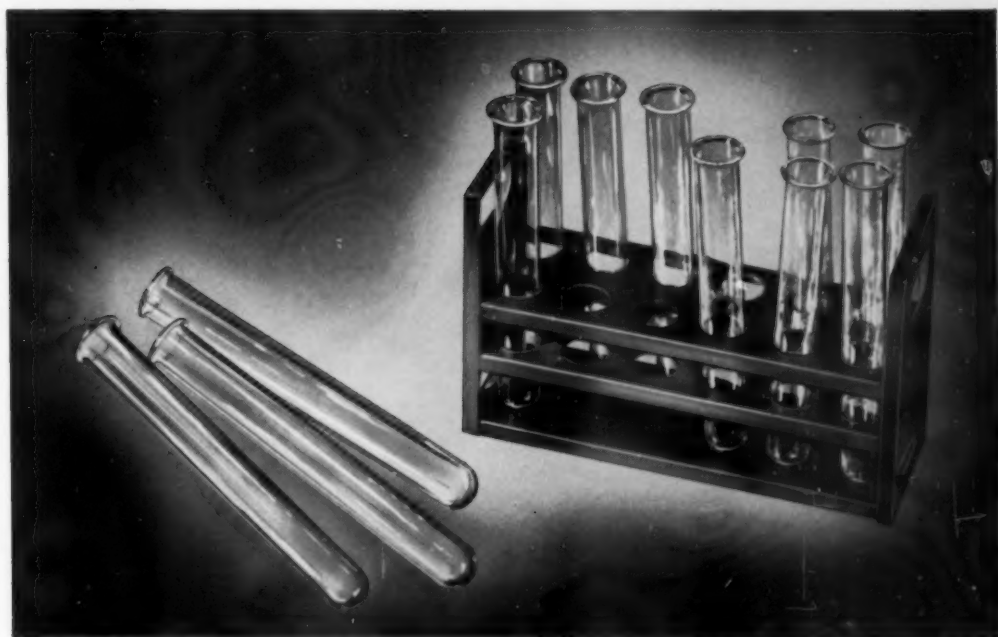
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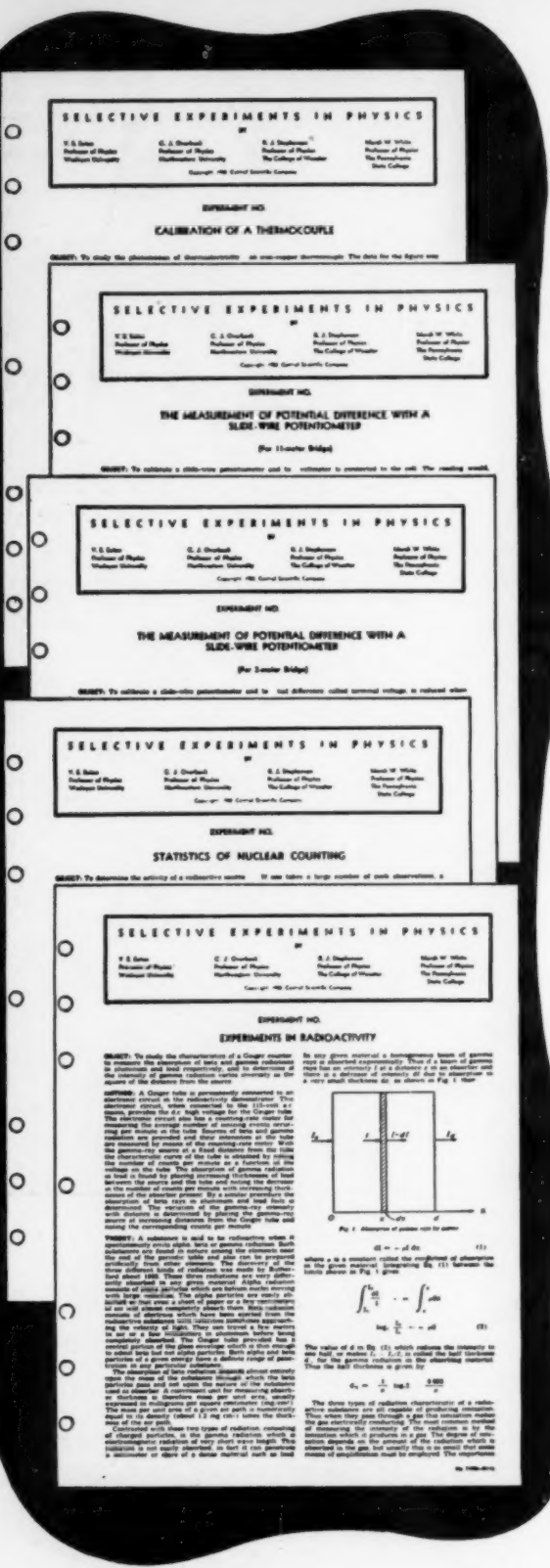
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